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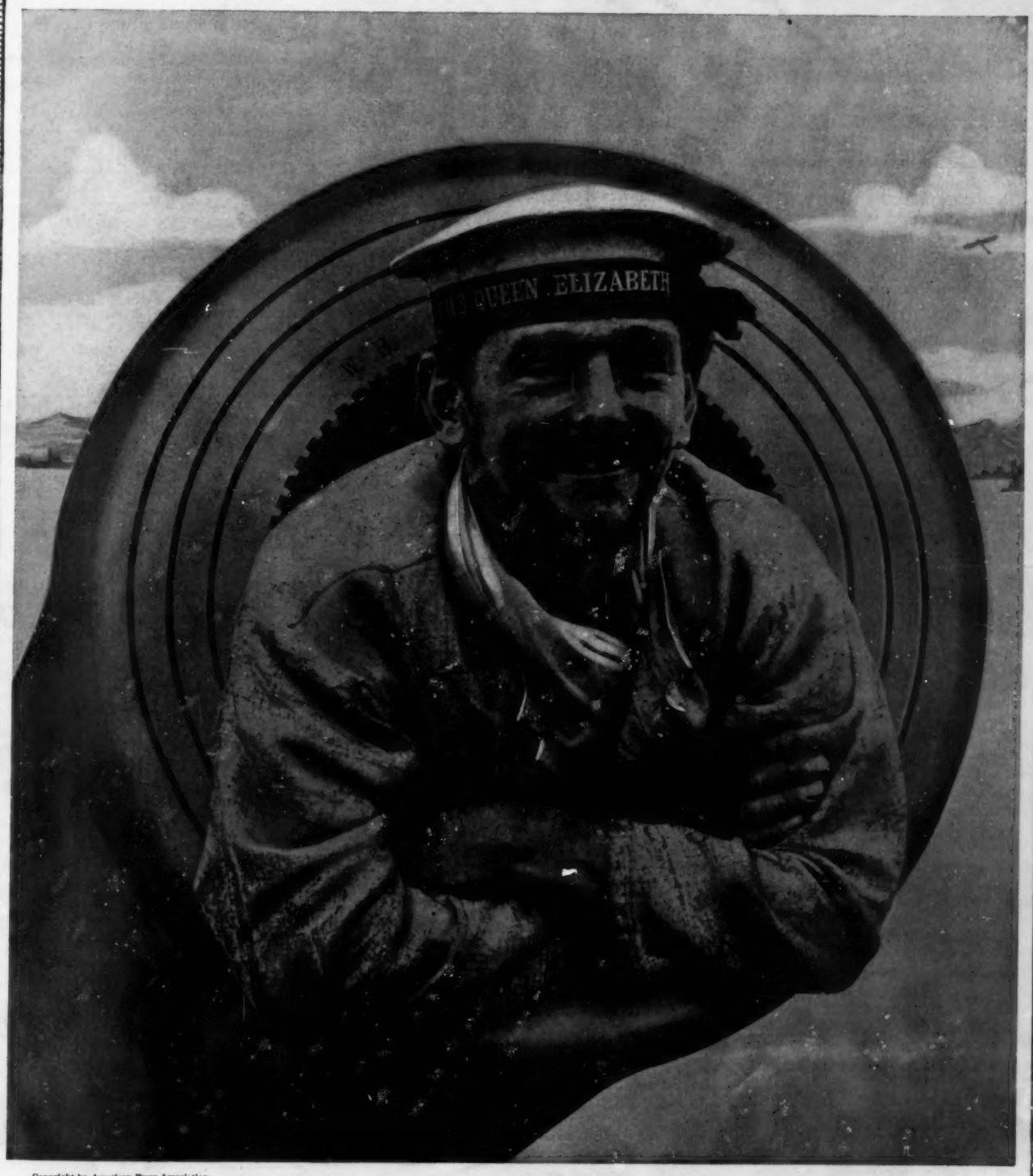

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MUZZLE OF THE "QUEEN ELIZABETH'S" 15-INCH GUN

Which is the Most Powerful Battleship?
A Military Expert on the War

Vol. CXIII. No. 4
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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp* the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

The purpose of this journal is to record accurately, simply, and interestingly, the world's progress in scientific knowledge and industrial achievement.

The Bureau of Invention and Development

THE SCIENTIFIC AMERICAN has so often felt itself called upon to criticise the policy of the present head of the Navy that it affords us very real pleasure to endorse Mr. Daniels's plan for the creation of a Bureau of Invention and Development.

The scope and plan of this movement are laid down by the Secretary in his letter to Thomas A. Edison, asking him to join the new board, in which he says: "One of the imperative needs of the Navy, in my judgment, is machinery and facilities for utilizing the natural inventive genius of Americans to meet the new conditions of warfare as shown abroad, and it is my intention if a practical way can be worked out as I think it can be, to establish at the earliest moment a Department of Invention and Development, to which all ideas and suggestions, either from the service or from civilian inventors, can be referred for determination as to whether they contain practical suggestions for us to take up and perfect. We, of course, receive many suggestions, but our only way of handling them at present is to leave them to various bureaus already overcrowded with routine work, and it is not always possible to give the necessary attention to propositions that are not so definitely worked out as to make them immediately available for the service."

In announcing that he would accept the Secretary's innovation, Mr. Edison made a suggestion, the importance of which, in its bearing upon the proposed board of invention, can scarcely be over-estimated. He suggested that in connection with the Secretary's Board there should be a department of experimentation, provided with the necessary buildings and plant and a corps of efficient men qualified to carry on experimental work under the direction of those who have made suggestions that have received the endorsement of the board.

Now, the idea of enlisting the inventive gifts of the whole nation in the service of the Navy by specific governmental invitation and encouragement is thoroughly sound in principle, and, if properly worked out, should prove to be thoroughly practical and a most useful aid to the development of naval material. In Germany the spirit of this movement, if not its definite official recognition, has long been at work, with results in scientific and mechanical efficiency which have astonished the world. Great Britain is lending ear to suggestions of the same character as uttered by H. G. Wells and by Prof. Ramsay.

Nobody understands better than Mr. Daniels and the technical experts of the Navy that the composition of the Board of Inventions and Developments is a matter calling for much thought and great discretion. That it should be highly expert goes without saying; for its voice should be so authoritative as to make its decision not only final, but convincing. The work of the board will not be easy; it will be flooded with suggestions ranging all the way from the crudest and most impractical ideas to those of the highest practical utility; and the task of detecting and sifting out those suggestions which have more or less promise of utility, and of determining from the inventions, as thus selected, which are of such importance as to call for immediate and very thorough test and development by the suggested department of experimentation, will be one calling for cool and unbiased judgment and a mind absolutely free from all prejudice against the inventor as such.

Governmental Indifference to Invention

THAT the present action of the Secretary of the Navy, looking to a proper recognition and encouragement of the inventor—a movement which we hope may extend to the sister service—has come none too early is evident if we look back over the past years and note how this indifference—we had almost said opposition—has been responsible for the loss to the United States of some of the most notable naval and military inventions of the age.

At the head of the list in point of time and importance is, of course, the machine gun, the inventor of which, Sir Hiram Maxim, had only to offer it for European inspection, to have the enormous value of his invention immediately recognized and find himself flooded with orders for his gun.

The invention of face-hardened, or carbonized, armorplate by the American, Harvey, was one of the most notable contributions to the art of warship construction; yet the reception of his great invention by the Navy Department was almost insultingly indifferent, and Harvey had to go to the courts, even after his armor plate had been adopted and used extensively in our Navy, before he could recover his just award.

The American, Janney, invented and perfected a speed-gear, so powerful and exact, as to make it possible for the gun-pointer to swing his 60-ton rifle on the target and hold it there with the ease with which a soldier handles his shoulder-piece. Exclusive rights were offered, if we remember rightly, to our Navy Department, and had they accepted we should have been enormously in advance of other nations in target practice. Janney went to Europe, where as usual, the American invention was recognized and adopted, and liberally financed.

Col. I. N. Lewis, one of the most brilliant artillery officers in our Army, designed a depression range-finder which he offered to the Government. It was turned down. Subsequently a private firm took up the matter, and now the Government is buying the range-finder which Col. Lewis patriotically offered several years ago to the Army gratis.

So also with the 25-pound machine-gun of the same inventor, probably the best for its weight in the market. The Lewis machine gun was offered to the Government. It was turned down. The colonel went to Europe. The merits of the American invention received their usual recognition in Europe. To-day, three of the allied nations are taking all of these machine guns that can be turned out.

The mobilization of the inventive genius of the nation! The history of the past would certainly suggest that this movement has been as badly needed in the Army as in the Navy. The new bureau movement should be made to include both branches of the service.

Peril of Our Military Unpreparedness

SOME time ago the SCIENTIFIC AMERICAN published a number of editorials which were afterward republished in pamphlet form under the caption "Our Country an Undefended Treasure Land." Since that time the great European war has continued with ever increasing violence. If there has been one lesson which has stood out above all others, it has been that the successful conduct of a modern war means organization in the greatest detail of the resources of the nation in men and material. Nothing must be left, as we are doing, to chance preparations, to be made, no one knows how, after war is upon us. It means preparation, in time of peace, of vast quantities of explosives, great quantities of small arms, machine guns to an extent never before dreamed of, *mobile* artillery, and, above all, artillery ammunition of all calibers, in amounts which surpass the dreams even of the artillerists of the days before this war. A small, highly trained army, such as was formerly considered adequate to meet the national emergencies pending the preparation of a larger force, would be of little or no avail in holding hundreds of miles of frontier or seacoast.

The lesson of the great war, so far as men go, is to the effect that a nation must have its male citizens instructed in the use of arms to an extent which will render them efficient soldiers. It must have prepared in advance its reserves of arms and ammunition, in quantities sufficient to equip the huge force of citizen soldiers which must be suddenly raised to meet the on-rush of a modern war. These forces of men are almost useless unless there are well-trained officers ready to take charge of them. Officers must be trained in time of peace. We have not enough to-day for our small peace army and militia at full strength.

It takes a long time and extensive machine plants to manufacture the *mobile* artillery of to-day, ranging, as it does, from the three-inch gun to the huge howitzer now present on the battlefields of Europe. Not only must guns be built and vast supplies of ammunition provided, but all the paraphernalia incidental to their handling and instalment must be made ready prior to the outbreak of war. Men must be instructed in their use. Are we taking any steps to make these preparations which no amount of money, enterprise, energy or patriotism can provide except with such delay as would be fatal to the successful conduct of war?

The answer is NO. Our half-filled regiments, *our reserve of regulars of sixteen men!* our puny supply of field artillery ammunition, the partially filled magazines of our seacoast batteries, our seacoast cannon on carriages which strip them of 40 per cent of their effective range and open our ports to bombardment by superior naval ordnance, without power of reply; our incomplete fire-control systems, our great shortage in searchlights, our Navy without reserves of men, without a single battle-cruiser, without adequate submarines—either in number, speed, or size; our alarming shortage of field artillery guns, and our total want of reserve officers to train our volunteers, our lack of preparation in the way of aeroplanes, in both Army and Navy—all point to failure to have taken heed from the lessons of the times, and to failure to have made even a reasonable degree of preparation. Anti-enlistment societies and leagues to induce emasculated young men to swear that they will not fight, add to the gravity of the situation. It is time—high time—to give heed to the dangerous pass to which ignorance, conceit and an unintelligent military policy have brought upon us.

It is reliably reported that the consumption of field artillery ammunition by the Teutonic allies has exceeded three times their maximum estimates. The puny reserve of the United States in the way of guns and ammunition is insignificant in amount. *The ammunition reserve reported in our previous publications is little more than a day's consumption by a group of allied forces.* Representatives of the fighting countries are beseeching our arms factories and ammunition factories for supplies. Limitless credit stands ready to pay practically any price we demand for high explosive shell, fuses, shrapnel, for small arms, and for certain forms of high explosives. The great war has lasted now for nearly a year. Money for the purchase of supplies in the United States has been practically limitless in amount. So far as the United States is concerned, a condition of profound peace has prevailed, and there has been not the slightest interference with the activity of her factories or powder works or in the manufacture of the desired supplies.

Has the United States been able to meet the demands made upon her? The answer is most decidedly NO. The output in shrapnel and explosive shell, judged from the standpoint of consumption in the great war, has been practically negligible. Is this because the United States is making demands upon private arms plants to fill up her own empty arsenals? The answer is emphatically NO. She is doing little or nothing in this direction. *She stands as she has stood for years—unprepared, unready, apparently unthinking, and without realization of the great danger which has come upon her through lack of reasonable preparation.*

Every American should draw this lesson from what has happened and is happening, so far as the production of military supplies is concerned, viz., that this great country—with all its mechanical development, with its industrial energy undisturbed by war, with every incentive to production in the way of prices, which know no maximum—has been unable to contribute materially to the conduct of the war, so far as small arms, shrapnel, high explosive shell and guns are concerned. If she has been unable to do this, when undisturbed, what would have been the condition had we been attacked, especially had the attack fallen upon the Atlantc seaboard and made lodgment where it surely will, namely, near the vitals of the country—which means somewhere between Boston and Washington, probably in the vicinity of New York? It is not difficult to answer this question when it is remembered that a circle with a radius of 165 miles, with New York as its center, covers the bulk of the arms-making and powder-producing facilities of the United States—nearly all of them within easy reach of the seacoast.

The present condition ought to bring home to every thoughtful American a realization of the grave danger to the country from a continuation of our present condition of unpreparedness and a realization of the folly—indeed worse than folly—involved in depending upon haphazard expedients to meet a degree of organization and preparedness such as the world has never before known. Can we not take warning from the lessons of the hour, or must we, without an adequate Navy and without any armed force worthy of the name (speaking in the terms of modern military preparedness) drift on unthinkingly, trusting ignorantly to the fallacy that none of our possible enemies will be free to attack us? We have been attempting to dictate to great countries their method of conducting war. We are absolutely unprepared to bring any form of pressure other than moral upon those with whose methods we disagree. A continuance of the present condition is dangerous to the very existence of the nation. Unless we prepare to defend our heritage we may lose it.

Science

Coffee Extract.—In a recent French patent, an integral coffee extract, having lost none of the properties of coffee due to volatile matter and aromatic products, is obtained by the following method of extraction. Powdered coffee is heated in a series of closed vessels to a heat lying near the roasting point, and it is traversed by a current of cold air or inert gas. Such air charged with aromatic parti les is sent direct into another set of chambers holding a dry powder or extract of coffee, this latter having been prepared from previously treated coffee which has been deprived of aromatic substances. Such dry extract is obtained by infusion, concentration, then evaporating and transforming to a dry powder. To this extract the aromatic substances are added.

Prickly Pear as Fodder.—A recent contribution to the old question of using prickly pear (*Opuntia*) as food for cattle takes the form of a bulletin of the Department of Agriculture of Bombay. The author describes experiments at the government dairy at Kirdee, in which six bullocks were fed with a mixture of 100 parts of prickly pear to 6 parts of cotton seed at the rate of 72 lbs. per 1000 lbs. live weight per day during six months. The spines, which form the well-known danger in feeding prickly pear, were burned off over a stove, after which the fodder was cut into small pieces by means of a chaff cutter or a chopper. This experiment and others proved that a mixture of prickly pear and cotton will not only support life, but will restore half-starved animals to a good condition.

Crops Injured by Lightning.—While everybody is familiar with the damage done by lightning to trees, little attention has heretofore been paid to the effects of lightning-stroke upon herbaceous plants. A recent paper by Messrs L. R. Jones and W. W. Gilbert reveals the fact that lightning injury is rather common in certain crops, especially cotton and potatoes. Grass, small grains and maize seem less liable to such damage. The lightning damage to cotton and potatoes frequently extends over roundish spots, one to three rods in diameter, or groups of smaller spots. Although there may be no disturbance of the soil or visible rupture of the plant tissues, the plants near the center of the spot wilt, blacken and die promptly, while those near the margin may live days or weeks. The injury for the most part appears first and worst below ground. All these facts seem to show that, after a period of dry weather, the lightning discharge occurring in a thunder shower spreads horizontally over the moist surface layer of soil. The different liability of different species appears to depend upon difference in tissue resistance or different distribution of the aerial or root systems of the plant within the zone of the discharge.

Effects of Town Smoke on Plants.—Further investigations on this subject have been made in and about the city of Leeds by Messrs. Crowther, Ruston and Stuart. At six stations ranging in location from the heart of the industrial area to a point six miles out of town crops of radishes, lettuce and cabbages were grown in wooden buckets sunk in the ground and all filled with soil taken from a common locality. The degree of atmospheric pollution was measured at each of these places by an examination of the annual rainfall as to its sulphur content. There was found to be a fairly close relation between the relative degree of atmospheric purity and the amount of plant growth obtainable, as well as the sulphur content of the crop. Moreover, the effects of atmospheric pollution appear to be cumulative, becoming worse with each succeeding crop. A chemical and bacteriological examination of the soil at the end of the experiments, which lasted three years, showed that the detrimental effect of the smoky atmosphere on plant growth is partly due to such unfavorable changes in the soil as the steady depletion of the stock of calcium carbonate and the inhibition of the activities of the nitrogen-adapting bacteria.

An Anti-typhoid Campaign, carried out in Yakima County, Wash., by the United States Public Health Service in co-operation with the local health authorities, has given striking results, which are described in a recent Public Health Bulletin. Prior to 1911 this county had every year a typhoid fever rate over three times as high as the average rate for the whole United States. In the summer of 1911 practical measures for the correction of the obviously insanitary conditions were recommended, and, what is much more important, were carried out by the people. The annual prevalence of typhoid has, in consequence, been reduced about 90 per cent. In North Yakima, the principal town and the county seat, while the population has considerably increased, the number of deaths from typhoid fever has dropped from thirty in 1911 to two in 1914; moreover, all the deaths from this cause during the last three years were of persons who had contracted the disease elsewhere. It is especially worthy of note that the sanitary improvements introduced have not only reduced the typhoid rate to the vanishing point, but have diminished the illness and mortality from other causes. For these great blessings the county has had to spend about $6,500 more per annum on its health service than it did before 1911.

Astronomy

The Number of Dark Stars.—It is reasonable to assume that the number of stars in space having a temperature so low that their radiations do not affect our eyes or photographic plates is extremely large. That these invisible stars are far more numerous than the luminous stars is suggested by Mr. F. A. Lindemann, who attempts, in the *Monthly Notices*, a rough calculation of their relative number, based on the assumption that new stars (novæ) are due to collisions. He concludes that there are about 4,000 times as many dark stars as bright ones.

Meteor Observations.—The National Academy of Science has awarded to the Leander McCormick Observatory a grant from the J. Lawrence Smith fund, to be used in meteor investigations. Dr. C. P. Olivier, of that observatory, announces in *Popular Astronomy* that this money will be expended in connection with the work and publications of the American Meteor Society. Additional members of the society are greatly needed; amateur astronomers and others who wish to join should write to Dr. Olivier, at the University of Virginia, Charlottesville, Va. The Society is distributing to members a set of star maps especially designed for meteor observations by Dr. Reynold Young of the Dominion Observatory, Ottawa.

The Second Annual Conference of the Society for Practical Astronomy.—The Second Annual Conference of the Society for Practical Astronomy will convene August 16, 17, and 18, at the University of Chicago, Chicago, Ill. All persons interested in astronomy, and friends of the science, whether members of the Society or not, are cordially invited to attend the regular sessions of the Conference, and will be made welcome there. The program will consist of papers from members, illustrated lectures on astronomical subjects, and *conversazioni*. For at least two of the evenings excursions have been planned to the Dearborn Observatory of Northwestern University, in Evanston, Ill., and to the (private) Petrajtys Observatory, in South Chicago, Ill.

Transneptunian Planets.—This subject has been discussed recently by Dr. H. H. Kritzinger, who states that while, on the one hand, it is now fairly certain that no intramercurial planets exist, astronomers are still confident of ultimately finding planets (probably two) outside the orbit of Neptune. The perturbations of Uranus should furnish some aid in the task of finding the nearest of the transneptunian planets (which Dr. Kritzinger proposes to call Pluto), but not so much as they would if we knew the mass of Neptune more accurately. From the work of Lau, of Copenhagen, Kritzinger concludes that there is a good chance of finding a transneptunian planet this year in Sagittarius or Capricornus.

Oxygen and Water Vapor in the Martian Atmosphere.—In the last number of the *American Museum Journal* Dr. Percival Lowell reviews the spectroscopic evidence in regard to the subject above mentioned, and presents a well-reproduced spectrogram of Mars, with two of the moons for comparison. A marked difference is seen in the absorption band of water vapor in the Martian and lunar spectra, respectively. In the case of the waterless moon, the absorption occurs only in the earth's atmosphere, while in the case of Mars the greater intensity of the absorption band points to absorption in the Martian atmosphere as well. Recent spectrograms obtained by Slipher actually show something as to the horizontal distribution of water vapor in the Martian atmosphere. The polar snow-cap was in process of melting, greatly increasing the humidity of the air in that region of the planet. Similar comparisons of lunar and Martian spectra prove, according to Prof. Very, the presence of oxygen in the atmosphere of Mars, about half as much as in the earth's atmosphere.

Neodymium for Identification of Lines in Stellar Spectra.—In the photographs of stellar spectra taken for the work of the Draper Memorial, an objective prism is used; i. e., a prism (or series of prisms) placed before the object-glass of the telescope, instead of at the eye-end. This has the advantage that there is very little loss of light and spectra are obtained over the whole field, but has the disadvantage that a comparison spectrum cannot be used, for the identification of the lines, as is done with the slit spectroscope. To offset the latter difficulty, experiments have been made with various absorbing mediums, the spectra being photographed so that the starlight passes through a tank containing such substance, and the lines resulting from the absorption of this medium are scattered among the lines resulting from absorption in the star's atmosphere. The terrestrial lines thus obtained have heretofore been too wide and ill-defined to serve the purpose of identification, but better results are now secured by the use of a ray filter filled with neodymium chloride, which gives a sharp neodymium line among the stellar lines. According to a recent article by Miss Cannon, excellent photographs are being taken by this method with the 16-inch Metcalf telescope.

Inventions

A New York City Beauty Spot.—Frederick Frankel of New York, has patented a beauty mark, patent No. 1,140,975, which includes a cut sparkling stone having an adhesive base by the aid of which the beauty spot may be stuck to the face of the wearer.

Coils the Telephone Receiver Wire.—Lorenzo E. Haynes of Salt Lake City, Utah, avoids any tanglings of the telephone cord connected with the receiver by a device in patent No. 1,140,780, including a coil spring which winds the cord up close to its connection with the base of the transmitter when the receiver is hung on the hook without interfering with the uncoiling of the cord, when it is desired to use the receiver.

New Button Fastening Method.—In patent No. 1,140,474 on the invention of Frank A. Miner of Windsor, Ontario, Canada, is presented a method of fastening buttons with eye shanks wherein the button shank is thrust through the fabric and a wire is pushed and guided through the eye of the shank and into the formation of a split or spiral ring in order to attach the button to the fabric.

Commercial Agent A. H. Baldwin of London notes that in a workshop near London glass receptacles of convenient size are used to contain screws, nails, hinges and similar small supplies. He suggests that here is an idea for American glass manufacturers for an extension of their products both for small household receptacles and for use in workshops. Possibly there is an opportunity for American inventors in the production of designs and mechanical improvements in containers for this special purpose.

Wants to Make All Shoes Comfortable.—Everyone hates to break in a new shoe and doubtless with this idea in mind two Milwaukee inventors, Harry M. Klingenfeld and Arthur H. Inbusch have patented, No. 1,140,599, a machine for breaking in shoes in which there is an endless belt traveling over a suitable base and leg-like levers have suitable foot portions to receive the shoes and are operated to move in simulation of a walking action upon the traveling platform so that the shoes may be actually broken in by a walking movement.

Another Folding Seat for Automobiles.—Judson E. Wright, assignor of one-half to Charles Frey, of San Diego, Cal., in a patent No. 1,140,931, provides improvements in automobiles wherein the seats and backs thereof are utilized to form a bed-like structure. In his improvement a seat continuation is hinged to and depends from the front edge of the front seat and a U-shaped rod beneath the front seat has its front and rear ends connected with the seat continuation and with the rear side of the front seat back in order to properly support said parts when adjusted to a reclining position.

Prize for a "Hall Mark" Design.—At a convention held early in June in Toronto, the Canadian Manufacturers' Association gave much attention to the "made in Canada" movement which received the hearty approval of the Convention and it was decided to have a design embodying the phrase "Made in Canada" copyrighted with the title vested in a committee of broad-minded and public-spirited men with authority to grant permission to use the design, and a prize of one hundred ($100) dollars has been offered for the most appropriate design according to reports from Commissioner Julius D. Dreber of Toronto.

Under the law going into effect July 1st, two new law clerks for the Patent Office have been appointed, to wit, Mr. William R. Ballard of Indiana and Mr. Charles H. Pierce of Tennessee, being promoted from the positions of First Assistant Examiners at $2,400 to a salary of $2,750 per annum, the latter being $50 in excess of the salary paid principal examiners. Both Messrs. Ballard and Pierce have been connected with the Patent Office examining force for many years and Mr. Ballard served a tour of duty as acting law clerk for several years under former Commissioner Moore. The addition of these law clerks to the Commissioner's staff will doubtless facilitate the adjudication of cases before the upper tribunal of the Patent Office.

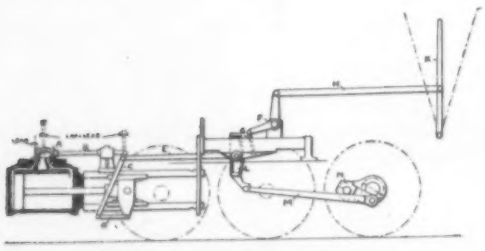
Manual Training and Invention.—The Principal of a Technical High School says that invention does not frequently manifest itself in the students of manual training. Probably this is true also of other students and it may be a fact or it may simply be a report of a failure to observe the manifestation. Other things being equal the student engaged in a manual study should develop the almost divine instinct and gift of invention more readily than one not so engaged and the greater the intelligence the greater the exercise of invention. This is demonstrated particularly in dentists, a body of men of superior intelligence, whose profession tends to increase their growth along mechanical lines. Many inventions are made by dentists, not only along dental lines, but in other directions. But invention is unconfined to employments or vocations and crops out wherever the spark glows in the production of some advance in the arts or contribution to the world's sum of novel ideas.

The Heart of the Locomotive

The Reason for the "Grasshopper" Valve Motions Seen on Modern Locomotives

By C. H. Claudy

THE human heart controls the circulation of the life blood. The valves of a steam engine control the circulation of its life blood—steam. If the valve acts well, the engine is prompt, economical, precise, powerful. If the valve is faulty, the engine lacks power, limps on its way, and allows its energy to run to waste.



Walschaerts valve gear diagram.

From the return crank *N* the connecting rod *M* works the link *L* in which the block at the end of the rod *E* slides. This block is raised and lowered by means of the reverse lever *K*, and the rods *H* and *F* and the joint *G*. The valve *A* and the valve rod *B* are worked jointly by the return crank motion and motion obtained from the cross-head through the rods *D* and *C*. The travel of the valve *A* is governed by the position of the block in the link, which is under the control of the engineer through the lever *K*. The lead of the valve is constant, and obtained through the motion of the cross-head.

At first glance it might not seem to the casual reader that there was anything very difficult in the making of a proper valve motion. But the locomotive designer has much to contend with that the stationary engineer has not. When it is considered that with an engine running at speed, the valve opens its ports or steam ways by less than half an inch, that a valve may operate ten times in a second, that a whole valve motion weighs from one to more than two tons, and that the least change in its exact working will affect both speed and power and coal consumption, and that it must work equally well in a yard at low speed or at high speed upon a rough track, then its making does not seem so simple.

A few years ago constant travelers noted, often with curiosity, that the trim American engine with which they had long been familiar had grown a new set of rods and cranks. The general public asked what this "grasshopper" was which had suddenly begun to appear among the familiar working parts of the engine. They called it "grasshopper" because, in motion, this valve gear, the real name of which is the Walschaerts, from its inventor, has ungainly rods and sharp-angled joints in operation.

It is more familiar now, as railroad after railroad has specified it on new equipment, and replaced the older or Stephenson valve motion or gear with this foreign invention. But its working and the reason for the change remain a sealed mystery to the man on the street, simple as these real reasons actually are.

It may be something of a shock to know that it is not a new valve motion, this gear with the peculiar name, and that for more than half a century it has been common in Europe. It seems strange that a country which has led the world in railroading should follow so long after Europe in this vital matter.

But the reason is not far to seek. Most foreign engines are "inside connected," that is, their cranks, pistons, cross-heads all work between the wheels and not on the outside of them, as with us. Hence, there was less space between the wheels for extra mechanism, and a valve gear which could be applied outside the wheels had a powerful argument in its favor.

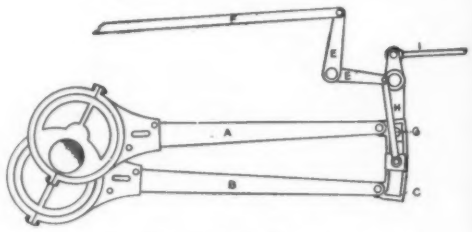
That is one of the reasons why American locomotives, particularly the larger ones, now have these strange steel "grasshoppers" on either side. The space between our wheels, too, is getting valuable. The familiar four eccentrics take up room. That room is needed for bracing, with the increase of weight and size of boilers. Hence, an outside gear made its appeal to American builders.

But matters of space and convenience are not all the arguments which have displaced the familiar "Stephenson link" gear with the Belgian machine shop foreman's peculiar device. To understand these other reasons is to understand something of what the heart of a locomotive really is and does.

Everyone knows that steam makes an engine go by being allowed to enter a cylinder in which is a piston. The pressure on the steam pushes the piston, which is connected by means of rods to the wheels, and so they turn. Most people will understand without being told that the steam is allowed to enter first one end of the cylinder and then the other, so that the piston is first pushed forward and then pushed back again.

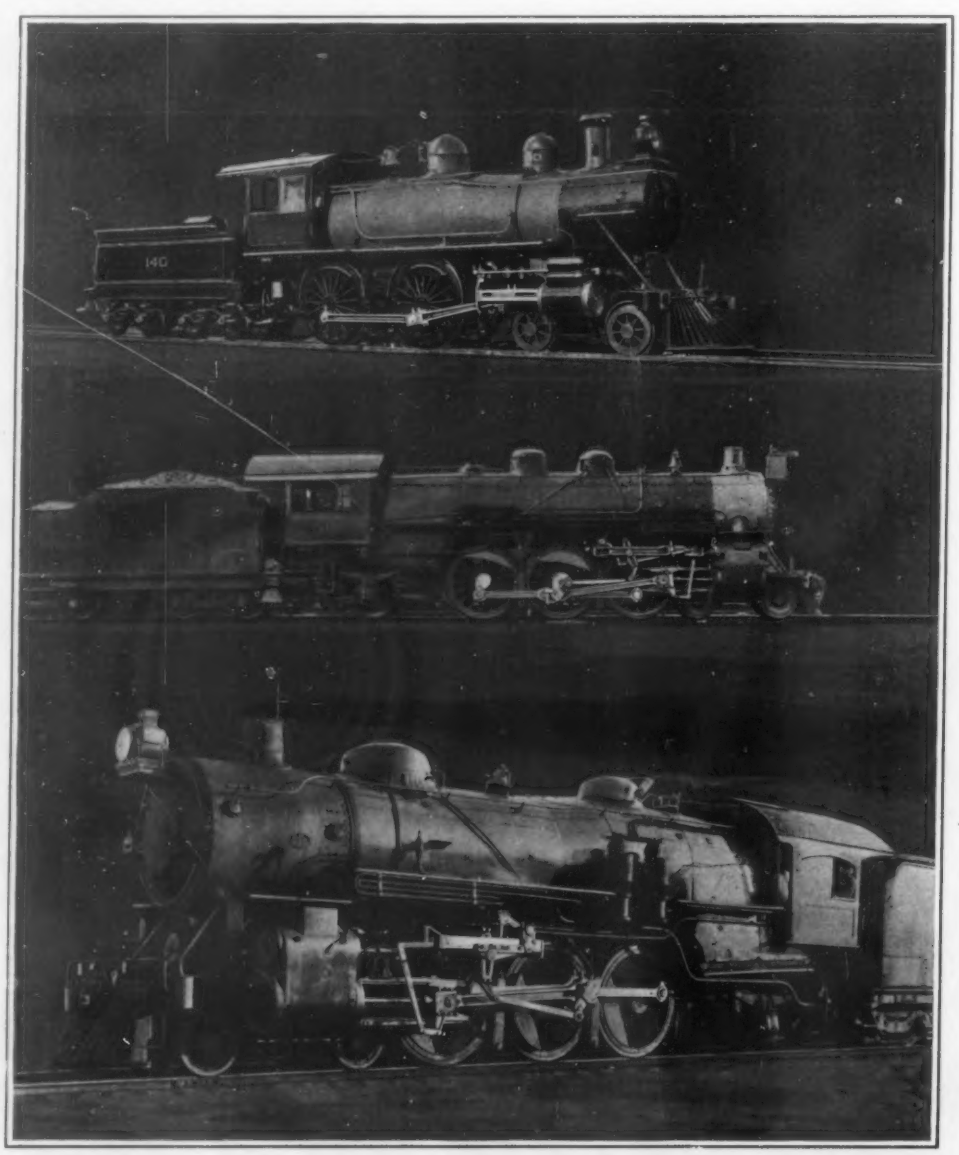
There must also, of course, be some way of letting the used steam out of the cylinder.

The letting the steam in and out again is the work of the valve. In the cylinder are two admission ports, through which steam flows from the steam chest into which it comes from the boiler. The exhaust steam comes out through these same ports, but not back into the steam chest, of course. Exhaust steam travels through the steam port not being used for letting steam into the cylinder, and out into the open air *via* the smoke stack, because the valve directs it, forces it to take that course. The valve, which, in its simplest form, is like the letter D laid on its side, and its upright taken away, covers first one port and the exhaust way, then the other port and the exhaust way. The valve works in the steam chest or valve chest, and is constantly surrounded by steam, so that the life blood of the engine is always pressing for admission to the cylinders.



Stephenson valve gear.

Two eccentrics *A* and *B* are connected with a link *C*, which can be raised and lowered by means of the link hanger and the arms *E E* and *F*, the latter leading to the reverse lever in the cab. The block *G* is fixed to the end of the rocking arm *H* from the top of which the valve rod *I* leads to the valve in the steam chest. The travel of the valve is under the control of the engineer, by means of the reverse lever, but the lead of the valve varies because raising and lowering the link has the same effect as slightly increasing or decreasing the amount of angular advance of the eccentrics. The lead is greater, in forward motion, the more the link is raised toward the central or neutral position. Extreme cut off, then, gives extreme lead, which is not always desirable. This feature is obviated in the Walschaerts motion, in which the link is pivoted and the block raised, lead being obtained not by the position of the eccentrics but from the cross-head.



Typical American express locomotives. Upper view an "American" or 4-4-0 model, with Stephenson valve gear. The other views show opposite sides of the "Pacific" models (4-6-2) fitted with the Walschaerts gear.

The valve in the Stephenson gear is worked forward and backward by means of eccentrics on the driving axle. If an engine had only to go forward, one eccentric would be enough. But because an engine must go either forward or backward, there are two eccentrics for each "slide valve." These are connected by rods to what is known as the "link," a curved, oblong frame, and in the link is a block, connected to the valve rod. The connection is made through what is known as a rocker arm, but it is not important in understanding the principle or function of the valve. When the link is down, one eccentric works the valve. When the link, by means of the reversing lever in the engineer's cab, is pulled *up*, the other eccentric works the valve and the engines goes the other way.

The theoretical position for the eccentric is at 90 degrees to the crank, so that, when the piston is at the exact end of its stroke,

(*Concluded on page 86.*)

Interlocking Steel Construction

A SYSTEM of fastening steel beams together without the use of rivets was recently tested at Columbia University with results that were surprisingly favorable. The webs and flanges of the beams were slotted or recessed and then they were interlocked in such a manner as to reinforce one another. The purpose of this construction is to dispense with the cost and labor of riveting in steel work.

In the accompanying engraving, Fig. 1 shows how a floor beam *E* may be secured to a column *D*, a slot *F* being cut in the column to receive the beam. A pair of clips *G* fit snugly over the upper flanges of the beam *E* and between the flanges of the column *t*, leaving a slot between them to receive column *H*.

Fig. 2 shows the construction of a bent such as would be used in a mine. A little study will show how the legs *A* fit into recesses in the beam *B* and are held from sliding out by clips *C*. The last are fitted on the beam *B* before it is slipped into place on the members *A*. The roof beams interlock with the clips *C*. The legs *A* are anchored in base-blocks as illustrated. Of course, the details of the joints will vary to meet the particular requirements of different structures.

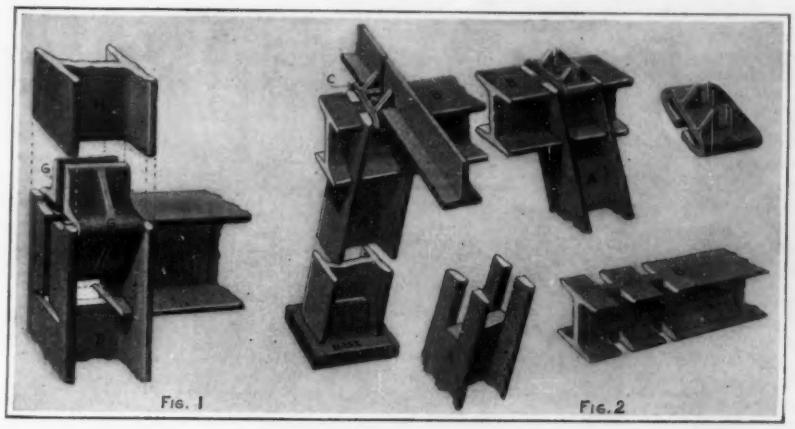
The structure tested at Columbia University was such as would be used on a four-tube subway.

Wait's interlocking steel is constructed by various ways of recessing the web and flanges of both the I and H beam to the necessary form of usage to which it is to be adapted; in so doing each joint reinforces itself, whether for subway, bridges or mining, and erections of buildings. The same basic principle is applied in each different construction, but necessitating various forms of locks independent of beams to unite the various angles or lines in construction.

The test of May 29th at Columbia University was a form for subway construction of a four-tube subway.

The test was a great surprise to all that were present. This section was formed of 4-inch H-beam columns and 6-inch I-beam girders. The second story was interlocked by one set of lock sections for continuing column supports. The I-beam indicated an equal stress on the beam to nearly 150,000 pounds before the giving away of the web of the upper I-beam. At 153,000 the stress was discontinued so as not to destroy the beam totally.

The lock or the columns did not show any failure and remained perfectly true in form. The damaged sections could be replaced in five minutes. The tapping of a 4-pound hammer was all that was necessary to remove them. A 6-inch I-beam is supposed to fail completely at 100,000 pounds where the flanges are not supported. As these were not supported, the 53,000 pounds of extra pressure indicated must have been distributed throughout the out-members constituting the complete unit. This would indicate that a construction of interlocking steel is one third stronger than where rivets are used.



System of steel construction that dispenses with rivets.

A Submarine Catcher

THE illustrations show a new method and apparatus for catching submarines, differing in many features from those previously described. Comparatively narrow channels to harbors are usually protected from submarines by mooring strong steel nets across the channel from shore to shore. Such protection, however, is not so well suited to large bodies of water, as bays and open roadsteads.

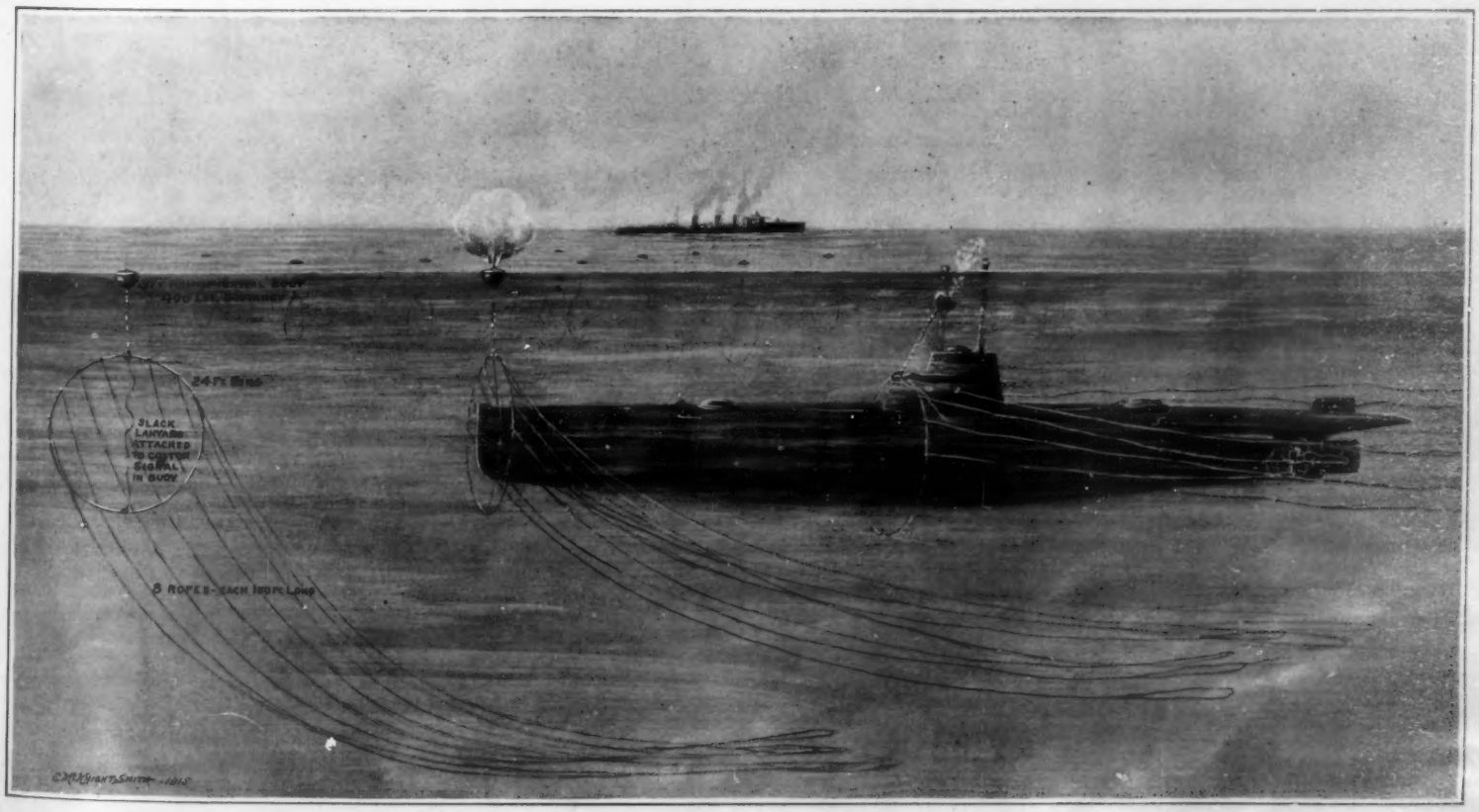
The device shown, submitted to us by Mr. Jesse W. Reno of New York city, appears to have considerable merit, and would be useful in discouraging submarine attack upon ships passing through extensive bodies of water. The plan is to drop overboard from a small cruiser several hundred of these "catchers" and leave them free to float back and forth with the current. It would be impossible for the enemy to locate them from the conning tower of a submarine, and therefore their presence in such waters would exert a powerful moral influence to prevent the free access of this terrible engine of destruction.

There can be little doubt that a submarine will be put out of commission if it enters, or even strikes a glancing blow against, the submerged ring of the "catcher." This ring, made of light gas pipe or angle iron, is 24 feet in diameter, and is suspended freely by chain to a float which is nearly submerged. Attached to the ring are eight ¾-inch ropes about 100 feet long with looped ends. The ropes are continuous in pairs and the attachment to the ring is such that it will easily break away and thus permit about 200 feet of rope to wrap around the propeller blades and shaft when the loop is caught. Inasmuch as all submarines have twin propellers, located at a considerable distance from each side of the keel, the chance that both propellers will be simultaneouly entangled in the trailing ropes is almost certain. The action of twin screws is to cause a powerful in-sweep of the water currents some distance forward of the stern, which would aid in bringing the ropes in contact with the blades. The "catcher" would have little or no effect upon the ordinary ship, the bow of which, if coming in contact with it, would not engage; in fact, the bow wave would probably push the "catcher" to one side, permitting it to drift astern. Assuming that a submarine has been caught in the manner described, her distress and location can be signaled by a simple device also invented by Mr. Reno, which will be clear from the following description.

A slack wire or lanyard is strung from the lower edge of the "catcher" ring and continued through a hole in the upper edge of the float. The float is provided with a conical hole through which the lanyard is passed, leading to a Coston signal flare contained in the upper end. As the submarine enters the ring it pulls the lanyard, setting off a delayed action fuse which will fire the flare, say one minute later, thus giving time for entanglement of the rope with the screws. The Coston signal can also be supplied with a substance producing a dense brown smoke visible for ten miles in daylight. A day and night signal of this character would enable a small cruiser or torpedo boat to capture or sink a submarine whose propellers were entangled and could not be operated.

The Interstate Commerce Commission and the Shipment of Natural Gas Gasoline

IN the final rules of the Interstate Commerce Commission regarding the shipment of natural gas gasoline it is suggestively stated that the commission has not deemed it best "at this time" to prohibit the use of good wooden barrels in shipping inflammable liquids with a flash point below 20 deg. Fahr. (—7 deg. Cent.), while requiring that liquefied petroleum gas must be shipped in metal barrels, drums or tank cars of a certain specification. We say suggestively stated, because the tendency appears to be toward the metal container exclusively and inventors or manufacturers of such containers or those contemplating such manufacture may well consider the possibility of improvements either in the product itself with a view to cheapening or improving the product itself or the process of its manufacture.



Catching submarines with ropes.

Strategic Moves of the War—July 14th, 1915

By Capt. Matthew E. Hanna, Recently of the General Staff, U. S. A.

THE week ending July 14th has not furnished us with the usual quota of spectacular moves in the Russian theater of the war, and the close of this period finds the world speculating on what the next important move is to be. At no previous time since the beginning of the famous Teuton drive through Galicia has the "fog of war" hung so thick over the thousand mile battle-front extending from the Baltic Sea to the Dniester River. For about two months the intent of German strategy was so clear, considered broadly, as to leave little room for doubt, but for two weeks, or since the battle lines reached approximately their present positions, the mystery surrounding the Teuton intentions and movements has deepened until students of the war are completely at sea and are anxiously waiting for developments that will give them their bearings.

The illuminating series of articles entitled "Strategic Moves of the War," the first of which appeared in our issue of June 19th, is from the pen of Capt. Matthew E. Hanna, recently of the General Staff U. S. A., whose work, "Tactical Principles and Problems," is the standard text-book in use in our Army.—EDITOR.

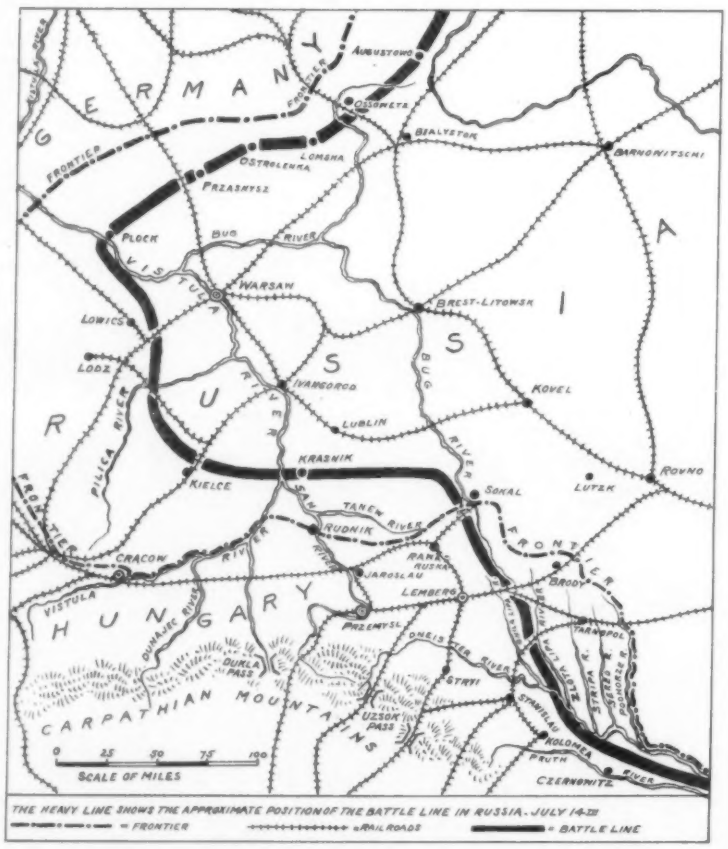
From the beginning of May, when the great German advance from Cracow began, until the end of June, when Lemberg was captured, one terrific drive after another was made against the Russians in a supreme effort to pierce their line on a front broad enough permanently to divide their army, as a preliminary step to the destruction of the two portions one at a time. But the Russians were able to avoid this catastrophe by a most skillfully conducted retreat which never lacked in resisting power at critical times and places sufficient to cover the withdrawal of the most dangerously threatened sections of the long battle line. Like a huge snake stretched across Poland and Galicia it twisted and turned under the lashing of the German armies until it finally occupied the position shown on the map of June 30th, when the east and west portion of the line ran from south of Kielce to Rawa-Ruska.

Up to this time the German drive had been almost due east, but the battle-front had become so contorted that a shift of the driving force to the north between the Vistula and Bug rivers seemed probable. To continue the eastern drive would strike the Russian line at its strongest point, for the Dniester and its five parallel northern tributaries in Galicia, together with the headwaters of the Bug River, constitute strong defensive ground. Also, a continued advance of the Germans to the east dangerously exposed their communications by way of Cracow, some two hundred miles to the rear. This danger could not be treated lightly, for the Russians, despite their shortage of arms and ammunition, have not been lacking in enterprise and initiative. The railway facilities about Warsaw, Brest-Litowsk and Ivangorod are so excellent as to make possible a speedy concentration of large Russian forces in this region, which with Ivangorod and Warsaw as bases, could advance along the railroads to the southwest against Cracow and the German rear.

For these and other reasons mentioned in these notes in other weeks, it appeared probable that the Germans would advance to the north between the Vistula and Bug rivers, taking Warsaw in the rear. After a period of inactivity lasting some days, this movement apparently was begun, and progressed without serious opposition until the region north of Krasnik was reached in the early part of the week covered by these notes. When about twenty miles south of the railway town of Lublin, which was an important objective of the Germans, they met the Russians in greater force and were driven back with considerable loss to the higher ground north of Krasnik, which they still occupy. For the second time the Teutonic forces have failed to penetrate far into this region, the other occasion being in the opening days of the war, when an unsuccessful attempt was made to capture Warsaw before the Russians could mobilize.

When the history of this war is written, if not before, we probably will learn that both of these failures were due to the influence of railways on military operations. A glance at the map will show that the German army in this region is completely without railway communications running in the direction of its advance—that is to the north. All its supplies of food and ammunition must be hauled over poor roads through a wooded and marshy country from the Cracow-Jaroslau Railroad, fifty miles south of Krasnik, and the haul increases with the advance until Ivangorod, fifty miles farther to the north, is captured.

For the Russians the conditions are just the reverse. On no section of their Polish frontier are the railroads better adapted to assist military operations. Brest-Litovsk, the greatest supply depot of Russia, and Warsaw, another great magazine, as well as the interior of Russia, can be drawn upon for food, ammunition, men, and arms. The railroad from Ivangorod through Lublin to Kovel is immediately behind the Russian line where it can distribute supplies and shift reserves from place to place on the front. The value of such a railroad may be appreciated when we recall that Russia built such a road behind her line at Mukden in the Russo-Japanese war.



The approximate position of the battle line in Russia, July 14th.

(The line extends beyond the northern limit of the map to the region of the Gulf of Riga, two hundred miles from Augustowo.)

The modern army is much more dependent upon railroads than formerly, and to advance without them against an enemy that has them available is well nigh impossible. A vast army might find it possible to collect sufficient wheel transportation to supply food and ammunition for small arms, but to haul the necessary quantities of artillery ammunition for any considerable distance without railroads would appear to be an impossibility. The Germans have surprised us often in this war, and they may do so again by advancing to Warsaw along this route, but they certainly should be stopped by the Russian line with the fortress of Ivangorod to protect its right flank and the Bug River to protect its left.

Hence the "fog of war" that conceals the probable developments of the near future, and beclouds the next strategic move of the Germans. Will they continue the Polish campaign, or have they already begun to withdraw troops from Russia for the drive into France? The purpose of these notes is to discuss what has happened, rather than to prophesy as to future events, but the situation seems to warrant a brief analysis of Germany's probable intentions. We may expect her to return to her unfinished task in the west as soon as she feels that she can keep out of the clutches of the Russian bear long enough to fight the French campaign to a decision, for decisive results somewhere are necessary to German success. But has that time come? The disparity between German and Russian strength is not as great as recent events indicate. If Russia were left undisturbed to repair her deficiencies, she might speedily turn the tables against the Germans, weakened by the withdrawal of a million men for the western battle front. And still, if the Germans were as skillful in retreat as they are powerful in advance, the territory they would sacrifice might be immaterial when compared with the overthrow of the French and British armies.

If she continues her Polish campaign, it will not be surprising if the advance on Warsaw is made from the north or west. The Russian line about Warsaw is a huge blunt salient most vulnerable to attack against one of its sides. The difficulties in the way of an attack from the south have been pointed out. These difficulties would not accompany an attack from the north, for in this region the German railway system favors the advance, even after crossing the frontier into Poland. To shift re-enforcements from the southern portion of the line by rail through Austria and Germany to the northern region would not be a difficult undertaking for the German railroad organization. If this shift were made the German line through Krasnik would have to hold fast while the advance from the north was being made. It might do this if sufficient supplies were collected in advance along the line it occupies.

It does not seem probable that Germany would abandon the attempt to take Warsaw when in a better position for its capture than at any previous time during the war. This city would be of great value to her, but still greater military benefit would result from depriving Russia of this important center of all Polish operations. If Germany were to give up the capture of Warsaw now it certainly would not be without keen regret.

Events during the week on other battle fronts have attracted more attention than usual, partly because of increased activity on those fronts and partly because of lessened activity on the Russian front. For more than two months, in fact, during the period of the German drive in Galicia, the French have been endeavoring by repeated attacks here and there to hold as many Germans as possible in the west. In this they have been aided by the British. At no time, however, have they attempted a concerted general effort all along the three hundred mile front with the idea of exerting their maximum strength in a supreme effort to break the German line and drive it from French and Belgian soil. The time for this appears not to have arrived, although the reason is not clear.

At no time have they seriously endangered the German position, although many local successes have been gained, and their efforts appear to have been wasted in so far as any interference with Germany's triumphal march through Galicia was concerned. In short, their attacks dangerously resemble half measures which seldom accomplish anything worth while in war. During the past week their attacks have been weaker and less frequent, and the Germans immediately assumed the offensive at strategic points from the North Sea to Alsace, recovering lost ground in some instances, and making new gains in others. Most notable of these, perhaps, was the widening of their salient by some hundreds of yards at St. Mihiel, where they have been holding on near the great fortress of Verdun since early in the war.

In the Italian theater there has been greater activity along the Isonzo River. The Italians have been bombarding the Austrian line at various points, but have not succeeded in delivering any infantry attacks of importance. In the Dardanelles, on the Gallipoli peninsula, the British and French have been fighting desperately against the Turk, and have made gains, which although measured in fractions of miles, are very important, since they bring them closer to the forts that are the key to the straits.

The initiative is still with the Teutons and the world is interestedly awaiting their next move.

Correspondence

[The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

Why a Whip Cracks

To the Editor of the SCIENTIFIC AMERICAN:

After reading "Why a Whip Cracks" in the SCIENTIFIC AMERICAN for April 3rd, I was incited to give my version of what takes place. Referring to Fig. 1, which represents a lash of a cattle whip set in motion in the direction of the arrow *a*, causing a current of air in its wake. When the whip is reversed, as shown in Fig. 2, it will roll back on the free end, which now moves by

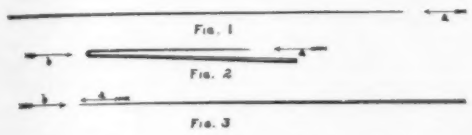


Diagram illustrating the cracking of a whip.

its own momentum, but not as fast as the part rolled back, causing another current as shown by arrow *b*. When the lash is completely unrolled as in Fig. 3 the two currents of air will meet with a concussion. Two essentials are required; it must be a slim taper so the two currents of air will be gradually brought in line, and it must be pliable so it will not retard the motion of the free end while rolling back. E. E. LARSON.

Thompson, Iowa.

Color Music

To the Editor of the SCIENTIFIC AMERICAN:

In your interesting article upon "Color Music" you state that "so far as we are aware Prof. Rimington's scheme was never carried out in practice upon a large scale."

May I ask the courtesy of the insertion of these few lines in correction of that statement, the facts being that I not only designed a color organ some years ago, but that several have been constructed.

I have one in my own studio, and performances of color music upon a large scale have been given with my instruments in St. James's Hall, London, and elsewhere, before audiences of more than 2,000 persons. It may perhaps be of interest if I add that the largest screen I have used measured about 50 feet by 30 feet.

Let me at the same time take this opportunity of saying that so far from disliking the rivalry of other inventors and other instruments for the purposes of the new art of mobile color with all its great possibilities, I welcome them cordially, and I congratulate the designers of the color piano used at the production of Scriabine's "Prometheus" in New York upon its success. In reply to a letter from them, I offered and gave any assistance I could.

Possibly it may be of further interest to your readers to know that Scriabine's "Prometheus" was to have been produced with the color score rendered by one of my instruments during this season at the Queen's Hall concerts in London had it not been for the war, and that the composer had another musical work in hand with a color accompaniment in accordance with my system of notation which might have been produced later on. That there is a great future for color music has now been generally conceded.

London, England. A. WALLACE RIMINGTON.

Automobile Pioneers

To the Editor of the SCIENTIFIC AMERICAN:

Many thanks for the copy and for the excellent presentation of my part in the automobile history in the seventieth anniversary number of the SCIENTIFIC AMERICAN. The presentation of the whole auto industry is excellent, as indeed is the whole paper.

Not in a spirit of criticism, but for future guidance, I beg liberty to suggest that your mention of Selden as the "first" in America is not correct nor fair to Brayton. I feel certain Brayton antedated Selden and Brayton was a real mechanic, whereas Selden was not. Perry, 1844 and 1846 United States patents, show a very real conception of the modern gas engine, air and water cooled, much better than Selden ever showed. Not only did Brayton's engine experiments and patents antedate Selden's experiment, but Brayton's omnibus and street car attempts antedated any construction of Selden so far as I have been able to learn. Selden claims conception back to 1877. I think you will find this in the sworn testimony in the Ford suit.

The Haynes car shown is the Haynes first with some rebuilding, but is not the one that was given a prize in 1895. The prize winner was a two-cylinder opposed engine device.

The King date seems to be wrong. That car appears in automobile journals of about 1896 as "King's testing car."

You confused my flying and automobile ambitions. I did not expect to take up flying till this century. I recognized the automobile as first and most important. While I kept an eye on the flying problems and advised with Chanute and others, I did not regard it as my problem and did not expect to solve it myself unless it was neglected so long that there was danger of its not being solved in my time.

I take the position that I foresaw the necessity of learning to fly more strongly than others, however. In the early nineties I advocated a flying school. Rope supported from an anchored balloon and the student and his machine dangling from the end. Perfect safety on a still day and chance to practice the various motions until confidence had been gained and knowledge of the motions and needs (see Report of Aero Congress at Chicago, 1893).

You gave me over-credit in connection with Providence automobile race. We lost, although having the fastest machine for any reasonable distance.

Winton's claim for first car sales is away off. The Duryea Motor Wagon Company of Springfield, Mass., sold automobiles in 1896, and put out the first circulars soliciting orders in the fall of 1895. Others even earlier had put out circulars, but they were not making goods as we were. Winton took a leading position later, but he was not first. Ignition by magneto was discussed by the Duryea brothers as early as 1893; was used by Sumner gas engine made in Cincinnati, Ohio, about 1898, if I remember rightly. We fitted small dynamos in 1896 and almost continuously thereafter, till good magnetos came into the market. I lit my headlight with a small dynamo in 1897. CHARLES E. DURYEA.

Philadelphia, Pa.

"Pennsylvania" and "Queen Elizabeth"

To the Editor of the SCIENTIFIC AMERICAN:

On March 16th, 1915, at Newport News, Va., our latest and largest battleship, the "Pennsylvania," was launched. At the launching of this leviathan the Secretary of the Navy in his address on that occasion made the statement and left the general impression with the people of this country that when this ship was completed it would be the most powerful in the world, greatly superior to the British super-dreadnought, "Queen Elizabeth," probably the most powerful in existence now. But when we consider the cold facts presented by the armament of the two ships, is this altogether true? Let us look at each vessel.

The "Queen Elizabeth" carries eight 15-inch guns whose range is at least 21,000 yards, as shown by their work in the Dardanelles, and she possesses a contract speed of 25 knots, but her 58,000 horse-power engines probably can develop even 27 knots. The "Pennsylvania" is content with twelve 14-inch guns, whose range is something like 18,000 yards. Her turbines, which develop only 31,500 horse-power, give her a speed of 21 knots. Armor is not being considered, for we are only seeing which vessel could land on the other and still keep herself out of the range of the other.

Now supposing such a calamity should befall us that our country and England should be drawn apart from a peace of more than a hundred years into a state of war, and supposing our "Pennsylvania" and the English "Queen Elizabeth" should meet upon the high seas, what would be the inevitable outcome? Because of the "Queen Elizabeth's" 15-inch guns and their advantage of 4,000 or 5,000 in range over the 14-inch guns of the "Pennsylvania" she would take her position just beyond the range of our guns, where she would be perfectly safe from our fire. And being possessed of 4 or 5 knots advantage of speed she could keep that range with perfect ease. The "Pennsylvania" would be helpless, and the terrific bursting and penetrating effect of the 15-inch shell would soon leave the "Pennsylvania" a helpless wreck. To sum the situation up it would be this: our guns could not land on the "Queen Elizabeth," because of their lack of range, and we could not get a closer range because of our lack of speed, and if the "Pennsylvania" attempted to flee it would easily be overtaken and destroyed just the same.

Our superior armor and weight of metal thrown would not affect the outcome in the least; it would only prolong the struggle. The fight between these two vessels would just be a repetition of that off the Falkland Islands, where the superior speed and the guns of longer range of the British ships won the running fight by totally destroying four fine German ships without any material damage to themselves. What good would it have done the "Scharnhorst" and the "Gneisenau" if they could have thrown three or four tons of metal more than the "Inflexible" and the "Invincible" if they did not possess the speed and the guns of sufficient range to put that advantage to use? The same would be true of our "Pennsylvania." Yes, the "Pennsylvania" would be clearly outclassed by the "Queen Elizabeth" when it came to a final struggle. The result of our discussion shows us that to have our ships equal to those of the "Queen Elizabeth" type, we must have superiority in one of two things, either in speed or in the range of our guns. CHARLES B. GARY.

Marion, Ind.

[Our correspondent is wrong in stating that the extreme range of the "Pennsylvania" is only 18,000 yards. At equal elevation the range of the 15-inch and the 14-inch guns is probably about the same—the initial velocity of the 15-inch being less than that of the 14-inch. The great advantage of the "Queen Elizabeth" lies in her superior speed and in the greater bursting charge of her 15-inch guns.—EDITOR.]

Fighting Efficiency of the "Iron Duke" and the "Kaiser"

To the Editor of the SCIENTIFIC AMERICAN:

I notice in your issue of March 6th an article by Charles Vornholt on "Comparative Fighting Value of Fighting Ships," in which he makes a comparison between the British battleship "Iron Duke" and the German battleship "Kaiser."

Through his method he finds that their efficiency is in the ratio "Kaiser," "Iron Duke" = 3,088, 3,426; approximately equal. Indeed, his finding is that "quite a few would bet on the 'Kaiser'" as a better fighting ship.

I disagree with his complicated method of comparison and entirely reject his conclusion that the "Kaiser" probably has the superiority in fighting value.

I think it should not be questioned that a true comparison of fighting value for such ships rests upon their offensive power and defensive power and speed in relation to these, under certain conditions. I say under certain conditions because the advantage of a knot or a knot and a half to a ship *fighting* would depend upon her possessing guns which would be effective beyond the range of those of the enemy. (Of course, speed has value for a ship if she wishes to avoid an action or get out of action.)

As will be shown presently, the "Kaiser's" knot and a half higher rating would give her no advantage in a fight with the "Iron Duke," because of the preponderating power of the British guns. Indeed, incidents of the war have shown that on different occasions British ships of lower rating than the German have not only been able to keep pace with them, but also overtake them on a test of speed, as in the case of the action of the battle-cruisers in the North Sea, and that of the "Kent" overtaking the "Nürnberg" in her flight from the Falkland Islands. In the light of such facts it seems doubtful whether the "Kaiser" is in any wise a faster ship than the "Iron Duke," although their contract speeds are 23½ knots and 22 knots, respectively.

The defensive and offensive powers of the two ships are as follows:

DEFENSIVE.

	Water-line Belt.	Side Armor above Belt.
"Iron Duke"	12 in.	10 in.
"Kaiser"	14 in.	8 in.

OFFENSIVE.

	Guns.	Weight of Shell.	Energy of Shell at 10 Miles Range.
"Iron Duke"	10—13.5 in.	1,400 lbs.	1,435 ft. tons
"Kaiser"	10—12 in.	860 lbs.	889 ft. tons

(Note.—All the British ships carrying the 13.5-caliber gun, with the exception of the "Lion" and the "Princess Royal" and the four battleships of the "Orion" class, carry the improved, or Mark II, type, which retains the same muzzle velocity as the original gun, but fires a 1,400-pound shell. This is the gun mounted on the "Iron Duke" and eight other battleships and two battle-cruisers in the British navy.)

It will be noticed that while the German ship has a thicker water-line belt, the British ship has side armor, above the belt, two inches thicker than has the "Kaiser." Thus, the high broadside above the water-line—that which would be oftenest hit—is very much weaker in armor in the "Kaiser's" case. We think it would not matter much whether the "Kaiser" was pierced at the water-line if a few 1,400-pound high-explosive shells plunged through her side a little higher up and burst between decks—it should reduce her speed.

Also, at a ten-mile range the 13.5-inch gun could do more damage to a 14-inch belt than the 12-inch gun could to a 12-inch belt. Then think of the difference of bursting power between a shell of 1,400 pounds and one of 860 pounds!

In the consideration of all this I would suppose that "quite a few" would bet on the "'Iron Duke."

I have based these remarks upon a case of ships fighting at sea at ten miles' range, for that seems to be the maximum in practice, so that is about the limit of aim and observation. A longer range, however, would give a proportional advantage to the "Iron Duke," with her immensely more powerful guns.

Moose Jaw, Sask. S. J. MESHER.

Which is the Most Powerful Battleship?

How the Big Gun Plus High Speed Make for Efficiency

By J. Bernard Walker

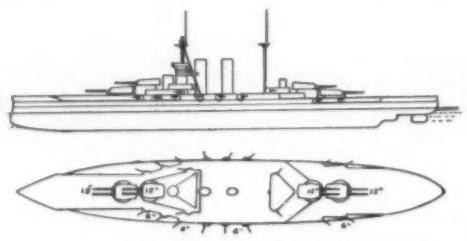
THE motive for the selection of topics to be discussed in our columns is frequently to be found in the letters which we receive from correspondents. Few subjects have been more prolific of letters of inquiry, at least during the present war, than that of the relative fighting efficiency of the United States ships "California" or "Pennsylvania"—they are practically sisters—and the much-discussed British battleship, "Queen Elizabeth," which has been taking such an active part in the operations at the Dardanelles.

In our endeavor to give the SCIENTIFIC AMERICAN'S answer to this question, we have decided to broaden the scope of the investigation and take in two other notable ships, the 16-gun "Tourville" of the French navy and the 12-gun "Fuso" of Japan. The particulars as to displacement, speed, armor, gun-fire, etc., of these four powerful ships are given beneath the respective illustrations and in the three accompanying tables, and therefore need not be elaborated in the text. The American, French, and Japanese ships are still under construction; and for the reason that no particulars are available as to the latest British designs of the battleship class, we are obliged to fall back upon the "Queen Elizabeth." It is for lack of particulars, also, that we are obliged to omit the new German super-dreadnoughts, of which nothing is known further than that they will probably be similar to the "Queen Elizabeth" and will carry a main battery of eight 15-inch guns.

Now we may as well make it clear at the outset that to determine the relative efficiency of two battleships of more or less widely different design is an exceedingly difficult and complicated proposition. The thing has been attempted, and by more than one naval expert. We are inclined to think that the method worked out several years ago by the German naval architect, Kretschmer, and known as the "P A Formula," gives the most reliable results. With true German elaboration and precision, Kretschmer went into the subject in very great detail, taking separate account of and comparing every element in the make-up of a warship which had its bearing, however small, upon the ultimate efficiency. We have neither the space nor, what is more important, the detailed information about the ships under consideration, which would be necessary to apply the Kretschmer formula. Instead, we have adopted his broad principle and applied it to the four leading elements in the make-up of a warship, namely, gun-fire, armor, speed and displacement.

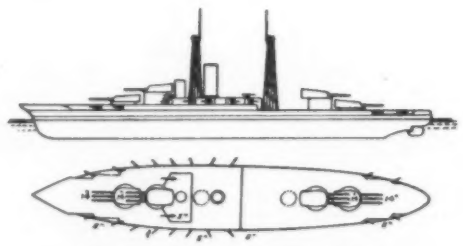
In order to make a satisfactory comparison it is necessary to make three broad assumptions. First, that the two fleets are fighting a line-of-battle engagement; second, that the battle-range has settled down to about 10,000 yards, which, in our belief, in spite of the preliminary firing at more distant ranges, will be about the distance at which the decisive phase of the engagement will be fought; third, that the gunnery of each of the four ships is equal in quality, and therefore that the percentage of hits per broadside or salvo is the same for all ships.

Turning now to table 3, in which is worked out the final rating of the ships as a whole, it will be noted that we have assigned in the first column a total of 100 points to the theoretically perfect ship. These points are assigned as follows: To gun-fire, 40; to armor, 30; to speed, 20; and to displacement, 10. This, of course, is an arbitrary sub-division. It merely represents our own impression of relative values. The gun enthusiast, who believes that, since armor can be penetrated, it may as well be thrown out altogether, might give a rating of 60 to gun-fire, 10 to armor and so forth; whereas the speed enthusiast might give 40 or 50



Gun and armor plans, "Queen Elizabeth."

to speed and be willing to cut down armor or guns accordingly. However, since the primary object of a battleship is to get as much high-explosive shell through the enemy's armor as possible in a given time, we rate



Gun and armor plans, "California."

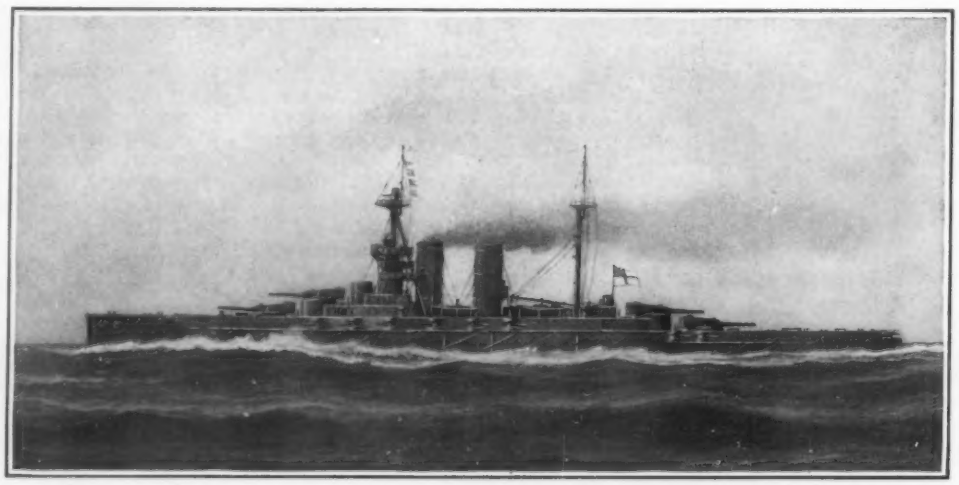
gun-fire first and give it 40 points. If a ship hopes to put more shells into the vitals of the enemy than she receives herself, she must preserve intact, as far as possible, her gun positions, her magazines, her engine room and other vitals. Hence, the value of armor and the very positive advantage of that extra two or three inches of thickness which serves to keep out the shell fire. Armor judged from this point of view has an offensive as well as a defensive value, and we have given it 30 points in our rating.

When once the two fleets are in touch and are eager to attack (which is the condition assumed in this study of the subject) the value of speed becomes purely tactical, and the faster ship, especially when there is a difference of four knots as between our "California" and the British "Queen Elizabeth," holds a decided advantage. A division of four or five "Queen Elizabeths" operating at the van or rear of its own column might be able to "Tee" the enemy, that is steam across its course and deliver raking broadsides up or down the line. We have given 20 points to the speed factor—an allowance which no doubt in the eyes of many of our readers will appear to be rather conservative. We are not, however, now considering the question of overtaking or escaping the enemy, nor the scouting or raiding operations of the swift battle-cruiser; for in that case we would give a higher rating.

Finally, we have given 10 points to displacement, every ton of which, in excess of that of a competing ship, means a distinct addition to efficiency, whether in additional coal supply or more elaborate bulkheading against torpedo attack, or stouter scantling in the structure of the hull, larger ammunition supply, or whatnot.

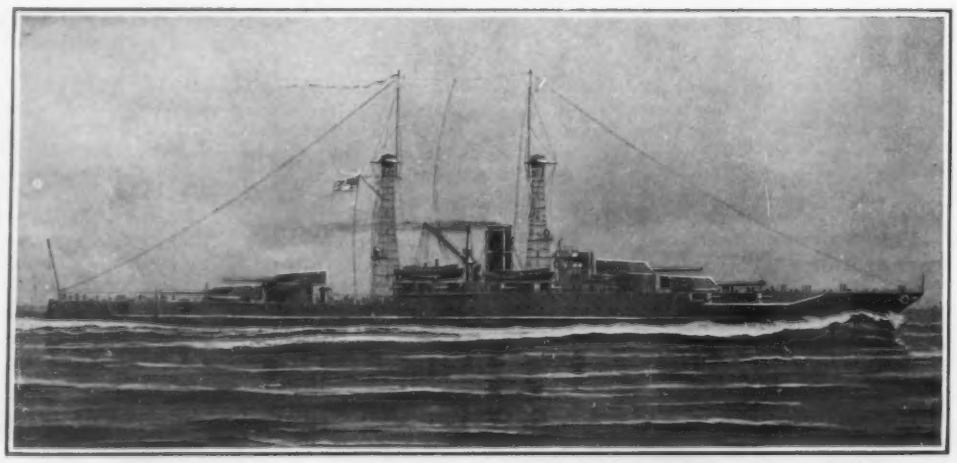
Taking up now in more detail the question of gun-fire, it would look at first sight as though the sixteen 13.4-inch guns of the French "Tourville," developing over one million foot-tons of energy at each salvo, would represent much greater offensive power than half the number of 15-inch guns on the "Queen Elizabeth," developing only 667,400 foot-tons muzzle energy at each salvo. On investigation, however, we find that the "Queen Elizabeth" has the larger punishing power, and we arrive at this result in the following way:

Since the gunnery is assumed to be equal, let us suppose that 25 per cent of the projectiles of each salvo hit the enemy. Since the belt is penetrable by all guns at 10,000 yards, this means that the four hits of the "Tourville" result in the placing of 5,328 pounds of explosive shell within the hull of the "Queen Elizabeth"; whereas the two hits of the "Queen Elizabeth" result in placing only 3,850 pounds of explosive shell within the "Tourville." That looks like a heavy preponderance in favor of the multi-gunned French ship. But we must remember that these shells have a delayed-action fuse which bursts them inside the ship's hull; and, since the 15-inch shell weighing 1,925 pounds is nearly 50 per cent larger than the 1,332-pound shell of the 13.4-inch gun, it follows that the bursting charge, the size of the fragments, and the penetrating and rending energy with which they strike must be proportionately greater—in fact, the damage done per pound of projectile will increase at least directly as the weight of the shell, and probably even faster than that. However, assuming that the wrecking effect increases as the mass of the individual fragments, and the velocity of the flying fragments is the same for the 15-inch and the 13.4-inch, we find the wrecking effect of the "Queen Elizabeth's" shells within the hull of the enemy is represented by 5,564 units, let us say, as against 5,328 units for those



Displacement, 27,500 tons. **Speed,** 25 knots. **Main battery,** Eight 15-inch. **Average belt and gun armor,** 13-inch.

British "Queen Elizabeth."



Displacement, 31,500 tons. **Speed,** 21 knots. **Main battery,** Twelve 14-inch. **Average belt and gun armor,** 15-inch.

United States "California."

TABLE I. SHOWING GUN POWER, ARMOR, SPEED AND DISPLACEMENT OF SHIPS.

	United States "California"	British "Queen Elizabeth"	French "Tourville"	Japanese "Fuso"
Gun power	12-14 in.	8-15 in.	16-13.4 in.	12-14 in.
Armor, belt and turrets, average	15 in.	13 in.	12 in.	12 in.
Speed in knots	21	25	23	22.5
Displacement in tons	31,500	27,500	29,500	31,000

TABLE II. SHOWING ARMAMENT, BROADSIDE ENERGY, AND RELATIVE EFFECT OF PENETRATING SHELLS.

	United States "California"	British "Queen Elizabeth"	French "Tourville"	Japanese "Fuso"
Type of gun	50-cal. 14"	45-cal. 15"	45-cal. 13.4"	45-cal. 14"
Wt. of shell, lbs.	1400	1925	1332	1400
Velocity, ft.-sec.	2700	2500	2675	2700
Muzzle energy, ft.-lbs.	70,770	83,425	65,388	70,770
Wt. of broadside lbs.	16,800	15,400	21,312	16,800
Energy of broadside ft.-tons	849,240	667,400	1,046,208	849,240
Hits per broadside at 25%	3	2	4	3
Wt. of metal penetrating enemy	4200	3850	5328	4200
Relative wrecking effect inside hull	4414	5564	5328	4414

of the "Tourville." Under the same readjustment our own and the Japanese 14-inch shells, three of which penetrate, are represented by 4,414 units.

Turning to table No. 3, it will be noted that the ship showing the largest efficiency under the several heads takes the full allotted points of rating. Thus, in gunfire the "Queen Elizabeth" leads with 40, followed by the "Tourville" with 38.30 and the "California" and "Fuso" each with 31.73 points. The "California" (see Table 1) is the most heavily and completely armored ship of the four, the average maximum thickness for belt and turret is assumed at 15, with 13 for the "Queen Elizabeth" and 12 inches for the "Tourville" and "Fuso."

In the matter of speed the "Queen Elizabeth," with 25 knots, naturally takes the full number of points, 20. She is followed by the "Tourville" with 18.4 points, the "Fuso," 18 points and the "California" with 16.8 points. We are free to confess that the hard-and-fast application of our rule in the matter of speed is not quite satisfactory. The difference of four knots between the "Queen Elizabeth" and the "California" would be of very material tactical advantage in a line of battle engagement; whereas the difference of a knot and a half between the Japanese "Fuso" and our "California" would not be sufficient to confer any material tactical advantage.

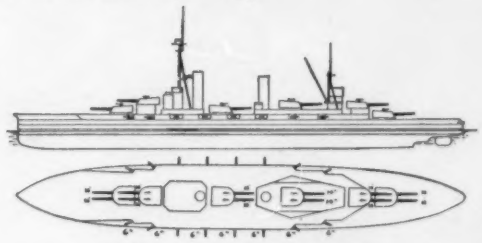
In displacement the "California" leads, followed closely by the "Fuso" and the "Tourville," with the "Elizabeth" a poor fourth. Here again the application of the rule may be disputed; for some will claim that the difference of 1.27 points out of a total of 100 for the whole ship, does not represent adequately the very material advantage of the "California" over the "Queen Elizabeth," due to her excess of 4,000 tons of displacement. Thus, under the blow of the same size torpedo, the loss of stability in the "California" and the danger of her being sunk would be very much less than it would in the case of the smaller ship.

TABLE III. SHOWING RELATIVE EFFICIENCY IN GUN POWER, ARMOR, SPEED AND DISPLACEMENT AND FINAL RATING OF SHIPS AS A WHOLE.

	Rel. Values	California	Q. Elizabeth	Tourville	Fuso
Gun Power	40	31.73	40.	38.30	31.73
Armor	30	30.	26.	24.	24.
Speed	20	16.8	20.	18.4	18.
Displacement	10	10.	8.73	9.36	9.84
	100	88.53	94.73	90.06	83.57

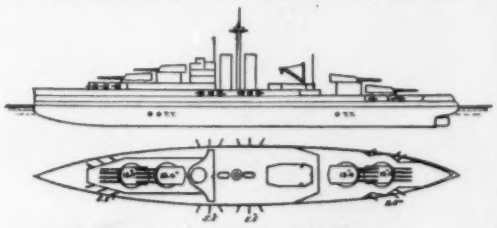
Rating of Ships

Queen Elizabeth 94.73
Tourville 90.06
California 88.53
Fuso 83.57

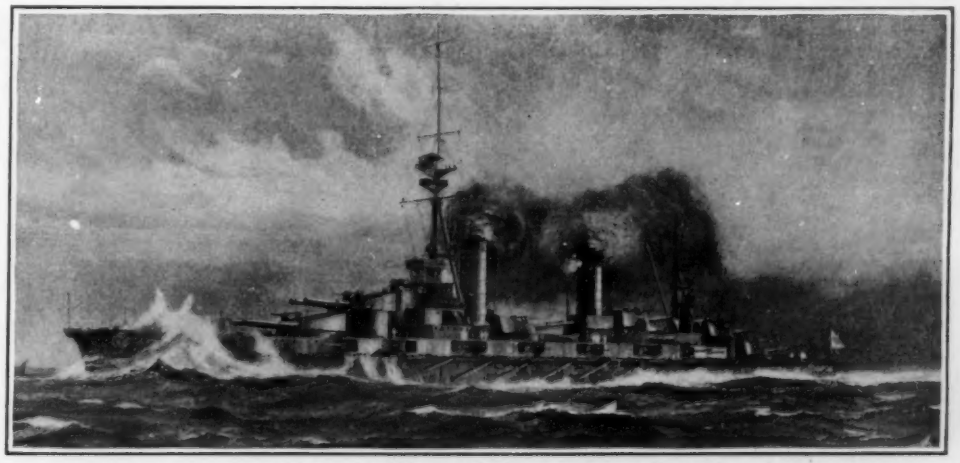


Gun and armor plans, "Fuso."

The final standing of these four super-dreadnoughts, we are free to confess, was a matter of surprise to us. We rather expected that the "California" would head the list, followed by the "Tourville," the "Queen Elizabeth" and the "Fuso." As it works out, however, we find the "Queen Elizabeth" is first with 94.73 points, followed by the "Tourville" with 90.06 points, the "California" with 88.53 points, and the "Fuso" with 83.57 points. It has to be admitted that our results seem to show that the British, who have generally led in naval construction, must have known what they were about when they increased the caliber, cut down the number of guns to eight, and raised the speed to 25 knots in a ship that possessed good defensive qualities.

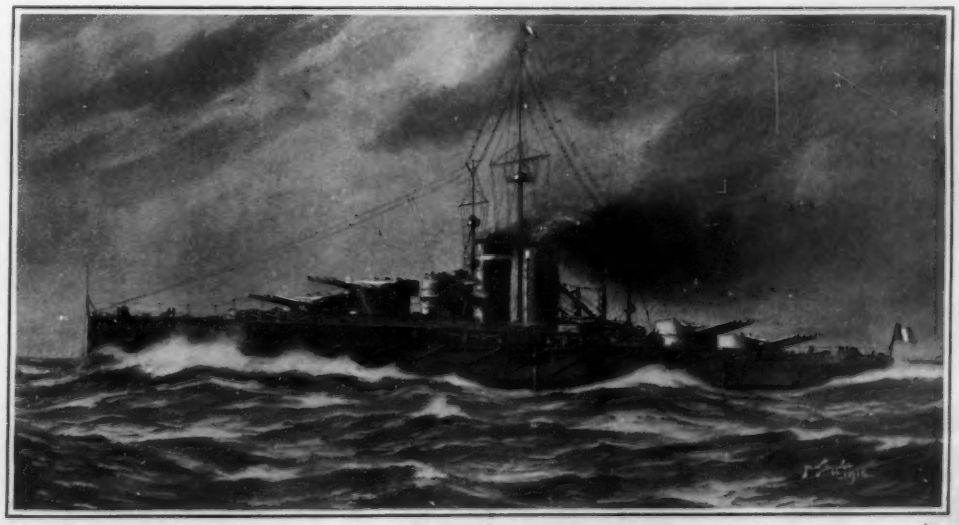


Gun and armor plans, "Tourville."



Displacement, 31,000 tons. Speed, 22.5 knots. Main battery, Twelve 14-inch. Belt and gun armor, 12-inch.

Japanese "Fuso."



Displacement, 29,500 tons. Speed, 23 knots. Main battery, Sixteen 13.4-inch. Belt and gun armor, 12-inch.

French "Tourville."

What Amount of Water Should Be Used in Concrete Mixtures

By H. Colin Campbell

ALTHOUGH the tendency is now to use wetter mixtures for concrete than prevailed in general practice some years ago, there is still controversy among self-styled authorities, engineers, and contractors as to the proper consistency for concrete mixtures. In most cases, the amount of water used has represented the arbitrary opinion of the engineer or person in responsible charge of the construction.

In reinforced concrete work, there is no question but that wet mixtures facilitate placing the concrete in intimate contact with the reinforcement, but in reinforced work there is a possibility that too much water will be used, so that after the process of crystallization has been completed in the cement, an examination of the concrete would show pockets or voids along the reinforcement.

The average contractor, simply for his own convenience, will frequently use more water in his concrete than necessary, because a wet mixture facilitates spouting, and consequently saves time and money in placing expense.

As in all things there must be a happy medium, so in concrete it is evident that the advocates of dry mixtures and the advocates of wet ones cannot both be correct. Tests have been recorded of experiments made in the Engineering Testing Laboratory of the Sheffield Scientific School, Yale University, involving experiments based on 1:2:4 mixtures, used with varying percentages of water. Conclusions based on these tests showed that concrete mixed with 27½ per cent of water developed at the end of thirty days a maximum resistance, both to tension and to compression, in comparison with mixtures made with other percentages of water. In other words, these scientific experiments pointed to the fact that there is a definite limit to the amount of water that should be used, and that this limit is much below that generally used in most construction.

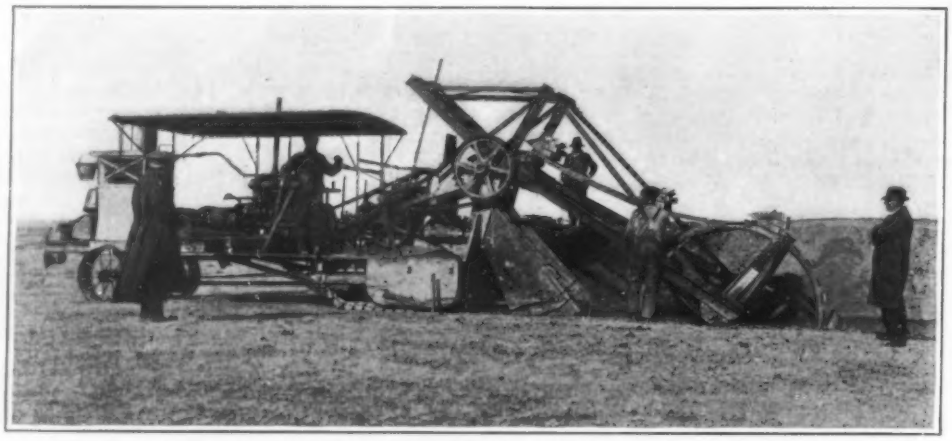
Another interesting point brought out by the tests referred to was that to attain corresponding strength in mixtures using 30 per cent and more of water, an increase from 5 per cent upward in materials was required to equal the results shown by the mixtures containing 27½ per cent water.

This means that for concrete to meet certain test requirements, the contractor may give himself a margin of 5 per cent or more for profit by adhering to the 27½ per cent content of water.

What a Patentee Claims.—In the case of Individual Drinking Cup Company v. United States Drinking Cup Company, 220 Fed. Rep. 331 it was held that a patentee is deemed to claim every form in which his invention may be copied unless he manifest an intention to disclaim some of those forms or where form and substance are inseparable.

Digging Battlefield Trenches by Machine

THERE is a great likelihood that the soldiers on the European battlefields may be spared the back-breaking experience of trench digging to a great degree by the utilization of machinery. Two powerful American trench digging machines have been in operation for some time at the Canadian camps, where corps of men who will ultimately be sent to the fighting front in Europe are being trained. These camps have already furnished 100,000 men, and at the present time there are 150,000 men in training. These men are thoroughly acquainted with life in the trenches, but the trenches have been dug for them by the American machinery referred to, thus relieving them of the hard shovel work.



An American ditching machine excavating trenches at a Canadian camp.

This innovation originated in the mind of Gen. Sam Hughes, commandant of the Canadian militia, and has proven quite successful and it is believed that the machines will soon be sent to Europe with the men who have been working about them. They are being operated under the control of Lieutenant Colonel Low of Ottawa. At Camp Sewall two of these machines dug seven miles of trench, five and a half feet deep with a two-foot bottom in ten days. They are readily moved about under their own power and will dig trenches of any reasonable depth or width with straight or sloping sides and will deliver the dirt taken therefrom on either side or both sides of the trench.

An Electrocution Trap for Insects

A GERMAN inventor has devised a very interesting electrocution trap for insects. Upon an insulated frame of either prismatic or globular form two naked metallic conductors are coiled in a spiral with a sufficient space between the windings. The two conductors are connected with a source of electricity in such a manner that the current cannot circulate until it is actually used in killing an insect. This is one of the advantages of the apparatus; obviously no electrical energy is wasted.

Insects are attracted either with sugar water or any other attractive substance. At night time electric lights can be used. The glare of shining metallic parts will also serve as an additional attraction. As soon as the insects touch the bait or the light, and come in contact with any two of the naked wires, they are electrocuted at once and drop down to the bottom of the trap. The current passes only for an instant and is very feeble.

Death of Joseph Austin Holmes, Director of the Federal Bureau of Mines

THE death of Joseph Austin Holmes, director of the United States Bureau of Mines, which occurred at Denver on the 13th, will come as a shock to a widespread circle of friends, for, although many knew his health was impaired when he went to Denver about four months ago, few were aware of the gravity of his danger.

Dr. Holmes was born at Laurens, S. C., 55 years ago, and after receiving his education at Cornell University, where he graduated in 1881, he was appointed professor of geology and natural history at the University of North Carolina, and shortly afterward was nominated as State Geologist, while still serving the university. During this period he was instrumental in getting the good roads laws passed in his State, permitting the use of convicts for road building.

In 1904 President Roosevelt appointed Dr. Holmes as chief of the United States Geological Survey Laboratories, where tests of fuels and building materials were conducted, and his work here was so successful that he was later appointed to the charge of the technical branch of the Geological Survey, which had charge of the investigation of mine accidents.

The wake of the big trenching machine.

In 1910 President Taft appointed Dr. Holmes as director of the newly established Bureau of Mines, in which position he has been instrumental in perfecting methods that have greatly lessened the dangers to which miners and other underground workers are exposed, and for saving life. Not the least of his plans are those for instructing miners in methods of saving life and the use of apparatus designed for the purpose, a work that has many times demonstrated the value of Dr. Holmes's ideas. In this branch of his work Dr. Holmes frequently exposed himself to serious dangers in his efforts to improve the conditions under which miners perform their work, and would never permit his assistants to go where he would not, even when it was at the expense of his health, which was not robust. The work of the Bureau of Mines under the direction of Dr. Holmes has been notable everywhere, both among scientific and practical men, for its vigorous methods and broad and valuable results.

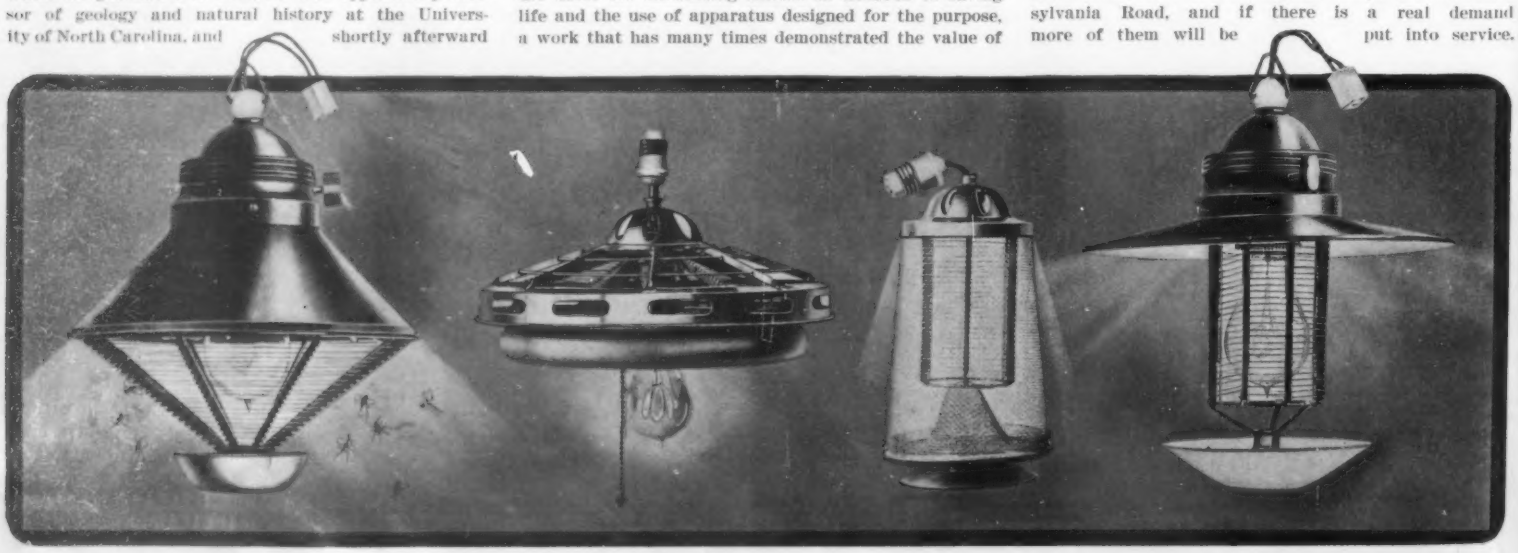
Besides his degree of B.S., he had received the degrees of LL.D. from the University of North Carolina and that of D.Sc. from the University of Pittsburgh. He was a member of the National Conservation Commission, the Mining Legislation Commission of Illinois, the American Society for Testing Materials, the American Institute of Mining Engineers, the Academies of Science of St. Louis and North Carolina, the American Society of Mechanical Engineers, the Cosmos Club of Washington, and the Engineers' Club of New York. Dr. Holmes was also a Fellow of the Geological Society of America. He is survived by his widow and four children.

The Current Supplement

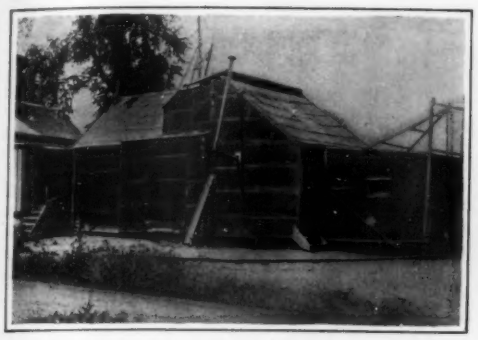
THE leading article in the current issue of the SCIENTIFIC AMERICAN SUPPLEMENT, No. 2064, for July 24th, 1915, is a discussion of Radioactivity, by Prof. Soddy, and considers recent advances in this theory, the study of which enables us to gain an insight into natural transmutation. Dr. Shufeldt, an eminent authority on natural history, writes an interesting article on the New York Aquarium, which is fully illustrated. An article from the German discusses that curious and mysterious phenomenon, ball lightning, and describes attempts to reproduce it in the laboratory. The preservation of sculptured records on ancient and inaccessible monuments has long been a problem. In this issue a description is given of a method of securing replicas by means of glue molds, a method that might be applied in other branches of exploration and science. How can we economize our fuel? Some valuable views on this subject are contained in the article on future methods of utilizing coal. There is an illustrated article on the railway exhibits at the Panama-Pacific Exhibition. Another instalment of the valuable article on recent progress in astrophysics is given.

Comfort in Travel

THE latest convenience and comfort in modern railroad travel is the broiler buffet day coach. This is an all-steel car of standard pattern that has a compact kitchenette installed in one end, with broilers operated with alcohol instead of coal. Meals are served on tables placed between the seats, with the outer ends resting on the arms, accommodations being afforded for two or four, as the seats are arranged. These cars are intended for use on trains where dining cars are not warranted by the travel. The first of these cars has been turned out at the Altoona shops of the Pennsylvania Road, and if there is a real demand more of them will be put into service.



Traps for electrocuting insects.



First moving picture studio in this country.

First Moving Picture Studio in the United States

WHEN we look at the vast number of moving-picture theaters in the country and the enormous masses of people that visit these amusement places, it is hard to realize how young the invention is. Of course, the basic idea is quite old, and even Edison's invention of the kinetoscope is over a score of years old, but it is only in comparatively recent times that the enormous commercial possibilities of this form of amusement have been realized. Evidence of this may be found in the accompanying photograph, which pictures the first moving-picture studio in the United States. This was constructed in 1905 by the Edison Company. It measured about twenty by twenty-five feet. It was mounted on pivots so that it could be swung around to the sun. It was also arranged to be carried from place to place on wheels. This gave it the nickname "Black Maria" by members of the company.

Certified Watches

By L. William Thavis

A LABORATORY for testing watches has been established at the Bureau of Standards. Here any watch may be tested and a certificate will be issued showing the results of the test. Soon it will be customary, according to Bureau plans, to ask for a certificate when purchasing a watch. Manufacturers already are sending high-priced watches to the Bureau of Standards, so that they may use the certificates thus gained as an inducement to customers.

Most of the high-grade watches made in this country are adjusted to either five or three positions. The five-position adjustment is made with the stem up (the position in which the watch is carried), with the stem to the right and to the left, and with the watch flat on its face and on its back. The three-position adjustment omits the stem right and left positions.

The tests used by the bureau are designed to cover the position, the temperature, and isochronism. The isochronism test refers to the uniformity of running of a watch throughout the day. To obtain this position test, the watches are placed in holders which may be turned to the position desired. The watches are run several days in each of the three or five positions. Then the series of position tests is repeated in reverse order.

The watches are kept in a compartment that resembles a large refrigerator with glass on three sides. In this compartment is maintained a constant temperature by means of a thermostat. The thermostat is used so that variations of temperature, caused by opening the door, are automatically corrected by the lighting of additional electric lamps. A thermograph is used to record the temperature. For low temperature a large brine coil above the compartment is provided so that the air may be pumped through it, and thus cool it to the freezing point if necessary.

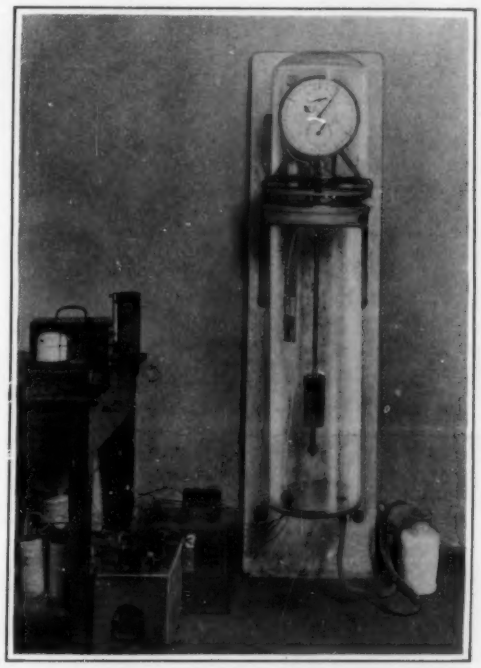
Readings of the watches are made through a small telescope placed in front of the glass testing case. These readings are recorded on a chronograph by means of a telegrapher's key. This chronograph is connected to the electric seconds contact of the bureau's mean-time clock. The telegraph key is tapped as the second hand of the watch reaches the fifty-eighth, sixtieth and second second-hand marks on the dial. Thus, the correction of the watch for each day is obtained within one tenth of a second. This chronograph contains a cylindrical drum, on which is placed a sheet of paper. The pen moves along this chart and makes a slight deviation, as the seconds are indicated by the click of the bureau's precision clock at the rate of one second per centimeter.

Both the isochronism and temperature tests are carried on with the temperature under thermostatic control. For temperature tests the watch is run five days at 5, 20, and 35 deg. Cent. (41, 68, and 95 deg. Fahr.). There is an unavoidable variation of a timepiece, graphically represented by a parabola, and this is allowed for by the tests. A watch usually runs faster at medium temperature than at low or high, so the graphic representation is made by a parabola, its reports on the temperature test.

In the wake of a cyclone.

Pranks of a Cyclone

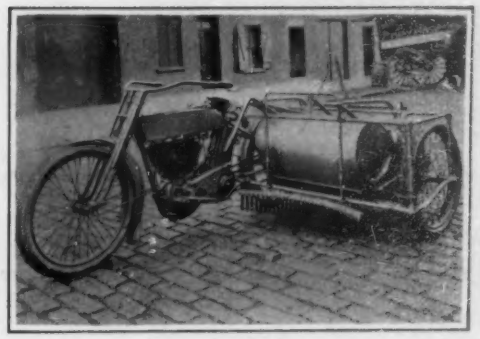
ALL manner of curious phenomena are to be found in the wake of a cyclone, and from time to time we have pictured some of them in these columns. The accompanying photograph, taken in Wisconsin, shows the wreck of a surrey, hung over the snag of a pine tree and wrapped around its trunk. In the background is shown a small heap of hay, which marks the site of a large barn that was carried away by the wind. The small building at the left was comparatively little damaged, while the large silo shown in the background, which was well filled with fodder, was actually moved several inches on its foundations and the upper part of it was badly damaged. A cyclone has an uncanny way of picking a particular object for its freakish pranks and leaving other objects adjacent practically undisturbed.



Precision standard time clock.

By this instrument clocks, watches, and chronometers are tested at the Bureau of Standards.

San Antonio's municipal bat roost.



A motorcycle street sweeper.

Motorcycle Street Sweeper

THE side-car has opened up many fields of usefulness for the motorcycle. One of the latest applications is shown in the accompanying photograph. The motorcycle is provided with a street-sweeping side-car. In front of the side-car is a steel brush which may be depressed so as to bring it into contact with the pavement. The brush then scrapes and loosens up the dirt, so that the rotary broom which is immediately behind it can sweep it up. A handle may be seen beside the driver's seat. When this is raised, the broom is lowered into contact with the pavement and caused to rotate. When the handle is lowered, the broom rotating mechanism is thrown out of operation. A machine of this type is particularly adapted for use on streets paved with asphalt or with wood. One of these machines has been tried out in Washington and has proved very efficient.

A Municipal Bat-Roost

THE only municipal bat-roost in the world was recently erected at San Antonio, Texas, and is expected to play an important part in the city's fight against malaria and other diseases. Dr. C. A. Campbell of San Antonio declares the bat to be one of the greatest enemies of the mosquito, which is largely responsible for the spread of malarial and other germs. For this reason San Antonio is not only protecting the bat by law, but has entered into the proposition of its cultivation.

Dr. Campbell is authority for the statement that the yearly toll of this nation to malaria is conservatively $100,000,000. He has also demonstrated that a single bat will consume as many as 260 mosquitoes in one night, and as it requires seven days for the cycle of evolution to complete itself in a mosquito that has bitten an infected person, before it can transmit the disease to another, it will be seen that in regions where many bats are flying all night, the chances of catching the mosquito and stopping the infection are very large.

Aside from the hygienic principles involved, there is also an economic feature to this proposition. Bats not only catch and eat the malarial mosquito, but convert the insoluble parts of its body into guano, which is one of the highest of all fertilizers. If a bat catches only 250 mosquitoes in one night, its droppings from this meal would weigh about 2¼ grains. At this rate, 250,000 of the creatures, which is the number capable of being housed by the San Antonio roost, would produce about 95 pounds of guano in one night, or something like 12 tons in a season of nine months—and guano is worth $40 a ton.

It is Dr. Campbell's idea that the bat-roost is a natural hygienic measure which should be adopted by governments, municipalities, or corporations controlling large bodies of land, and who are financially able to erect enough of the roosts to protect their tenants. The roosts, however, must be constructed from a scientific standpoint, so that they will not only attract bats, but induce them to live there permanently.

Life Saver for Aeronauts.—R. Simon of Perth Amboy, New Jersey in patent No. 1,140,273, presents a life saving suit involving a cushioned cap and back and front pads for the body communicating so that they can be blown up by a tube extending to the mouth of the aviator, communicating pads being provided on opposite sides of the legs and yielding spring supported shoes, being carried on the feet and the center of gravity being well below the waist so that in falling the person will fall feet foremost.

Inventions New and Interesting

Simple Patent Law: Patent Office News: Notes on Trademarks

A Wind-shield Cleaner Invented by Prince Henry

MANY who remember the visit made by Prince Henry of Germany to this country some years ago knew that he was quite a practical man with a considerable taste for things mechanical, but probably few people are aware that he has figured in the United States Patent Office as an inventor. The patent in question is for an appliance for cleaning wind shields on motor vehicles, and is issued to "Heinrich Prinz von Preussen, of Kiel, Germany." After reciting, in the patent specification, the general construction of wind shields, and the difficulties resulting from dirt and rain collecting thereon, he proceeds to say: "I propose to remedy this defect by providing wipers, either on one or on both sides of the glass, which by a quick stroke of the driver may be moved over the glass to remove the adherent dust and water therefrom. Devices for wiping off glass shields are known in the art.

"The particular advantage of my novel device over those known, however, is its simplicity in construction and the feature that by the up and down stroke the wipers are automatically pressed against the glass without particular effort of the operator to that effect."

The device described in the patent is shown in a general way in the accompanying illustration, and it will be seen that the wiping bar, located across the forward side of the glass screen, carries two wipers set at right angles with each other, one of which is brought into contact with the glass on the down stroke, and the other on the up stroke. This wiper is mounted at one end on a cross bar that is fixed to a sleeve that slides on a vertical bar attached to one edge of the shield by brackets at top and bottom. This sleeve is provided with ball bearings at each end so that it works without friction on the guide rod. In order to hold the wiper in contact with the glass, a rod parallel with the inner side of the glass shield, and carrying a roller at its end, is fixed to the opposite end of the cross bar to that which carries the wiper. The roller shown in the picture bears against the inner face of the glass, and, by its lever action on the cross bar, holds the wiper against the opposite side of the glass shield. The wiper bar is pivoted in the cross bar, carried by the sleeve, and has a rearwardly projecting lever that engages with a similar lever projection of the operating handle. Also connected with the wiper bar is a latch *B* held in position by a spring *C* that engages with the catch *A* when the device is not in use, thus holding it out of the way.

When it is desired to clean the glass the handle is grasped and pulled down. This action releases the latch *B* and draws the wiper down across the glass, the upper one of the two wiping strips being in contact. A reversal of the motion draws the lower wiping strip upward over the glass, and the latch automatically engages with the catch *A* when the stroke is completed.

The patent was issued last summer, and was assigned to the firm of Heinrich Wollheim & Ossenbach, Industriegesellschaft, M.B.H., of Berlin.

Prince Henry's automobile shield.

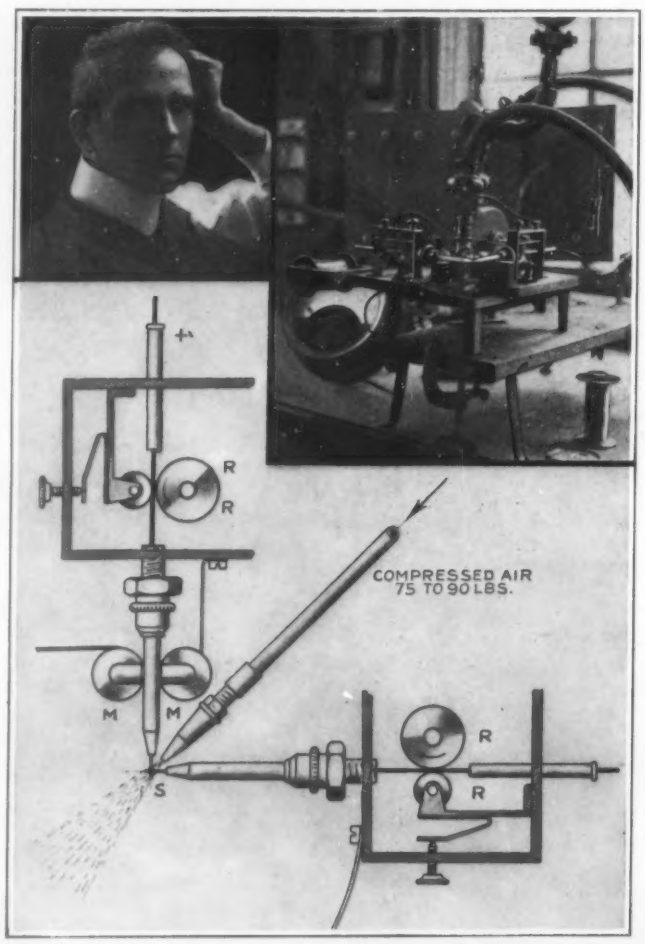
Plating by Shooting

READERS of the SCIENTIFIC AMERICAN are more or less familiar with the metallizing spray system invented by M. U. Schoop, a Swiss engineer. Those who have read the article which appeared in the SCIENTIFIC AMERICAN of April 17th, 1915, will remember that a solid wire is pulverized and the metal particles are shot upon the object to be plated. A "pistol" is used, as the apparatus is aptly termed, an instrument which straightens the metal wire, feeds it at a speed which may be regulated at will, concentrates upon the wire gases which melt it and atomize it. A current of air or gas is used to carry the metal particles to their destination. The effect obtained is purely mechanical, the metal particles adhering firmly by impact to the object at which they are projected. In the modified Schoop system described in the SCIENTIFIC AMERICAN of April 17th, the pistol consists of three concentric barrels. The innermost is that through which the wire issues. The second tube conducts to the place selected for the melting point a jet of mixed gases under pressure, in fact a blowpipe; while the outer annulus delivers compressed gas which furnishes the velocity necessary for the spray. The blowpipe mixture is coal gas, water gas, acetylene, hydrogen or the like, with air or oxygen for its stimulation, while the spraying jet is carbon dioxide, nitrogen, air, steam or the like.

Mr. Schoop has now devised an improved apparatus. As our illustration shows, this consists not of a gaseous but of an electrical atomizer and metallizer. Two rectangularly disposed metal wires conduct the current. An electric arc is formed at the junction of the wires, with the result that the metal is melted. The molten metal is atomized continuously by a blast of compressed air delivered from a blowpipe disposed at the proper angle. Thus the metal particles are blown upon the object to be plated. The tension of the electric current depends upon the thickness of the wire, the melting temperature of the wire, and upon the nature of the current at hand, whether it be alternating or direct.

The operation of this new metal plating device is obvious from the accompanying illustration. It should be mentioned, however, that the tubes through which the wires are fed are electro-magnetically vibrated, the object being to prevent the wires from melting together at their point of juncture *S*. The rollers *RR* serve the purpose of feeding the wire at a uniform rate to the arc *S*.

Mr. Schoop devised this apparatus primarily to meet the need for a device which could be used where compressed gases were not available, and where the ordinary oxy-acetylene or oxyhydrogen blowpipe could not be used.



The improved Schoop metal spraying apparatus, with inventor's portrait.

An electric arc is employed instead of a blowpipe to melt the metal wire.

Cancelation of the Ten-year Clause

IN a recent case in the Second Circuit of the United States Circuit Court of Appeals, Judge Lacombe, in rendering the decision in the case of Hermanus R. Planten, Complainant-appellant v. James W. Gedney, defendant-appellee, took occasion in the course of the decision to discuss the trademark practice especially with respect to cancelation proceedings. The case was a suit for infringement of two trademarks registered under the act of February 20th, 1905. The court stated, "Before a certificate can be issued the trademark must be published for thirty days in the *Official Gazette*, within which time anyone may file objections. It will, of course, frequently happen that such published notice fails to reach some person interested and, therefore, objections which the Patent Office might have considered fatal to the application are not presented. In consequence registration will sometimes be improvidently granted, the office being misled as to length of time by prior use, or as to its exclusive character. For such cases the act provides, in the thirteenth section, a remedy by application to the Commissioner of Patents for cancelation of the registration. The remedy is full, fair, and summary, with appeal from the Examiner to the Commissioner, and with no time limit for the application. It may be strongly urged that for an improvident registration this remedy should be exclusive, leaving it for the tribunal which had decided on insufficient evidence that there had been ten full years exclusive use to reach a different conclusion on fuller testimony.

"Many other defenses to a suit upon registered trademarks can be disposed of only in suit. . . . But it may be that Congress intended that as to two questions whether prior use was for ten full years and was exclusive the Patent Office should decide. He went on to say that such question of practice need not be decided in the case before him, but his remarks are indicative of what the court might do in a case where the only defenses were those before suggested."

Ore Flotation Litigation

AMONG the patent suits argued and awaiting decision, one of the most important is the flotation suit of Minerals Separator, Ltd., v. Miami Copper Company, heard for many weeks this spring and finally submitted late in May. The details of this suit are fairly familiar to those directly interested in the tremendous practical importance of the proposition. The case was argued at length by Messrs. Henry D. Williams and William Houston Kenyon, both of New York, and Messrs. Walter A. Scott and Thomas F. Sheridan of Chicago. The record of the case presented includes a comprehensive discussion of the art prior to the patents forming the basis of the suit, including actual practical demonstrations of a number of patented machines. Judge Bradford's decision will not likely be rendered until the fall term.

RECENTLY PATENTED INVENTIONS

These columns are open to all patentees. The notices are inserted by special arrangement with the inventors. Terms on application to the Advertising Department of the SCIENTIFIC AMERICAN.

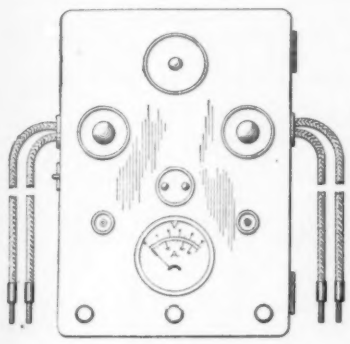
Pertaining to Apparel.

UNDERGARMENT.—W. R. SCHREMP, 377 Broadway, New York, N. Y. In this case use is made of an elastic ribbed knit fabric, inserted in the body of the garment and having its wales extending horizontally approximately at right angles to the wales of the body of the garment, thus allowing the yoke to stretch in an up and down direction.

Electrical Devices.

TELEPHONE RECEIVER SUPPORT.—A. H. DRAKE, Waterloo, Iowa. An object of this invention is to provide a supporting arm for a receiver which may be shifted from one position to another so that at one time the arm will depress the receiver hook, and at another time the arm will hold the receiver adjacent the ear.

ELECTRIC TESTING INSTRUMENT.—H. SCHADE, Quail and Elk Sts., Albany, N. Y. Mr. Schade's invention relates to a testing box, primarily intended for use on automobiles, whereby electric fuses, lamps and batteries can



ELECTRIC TESTING INSTRUMENT FOR AUTOMOBILES, ETC.

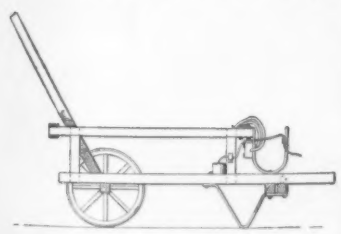
be conveniently tested for their amperage and voltage, and also if they are damaged. The testing box is neat in appearance and a simple and inexpensive device which is portable, so that it can be used in any convenient place.

Of Interest to Farmers.

CRANBERRY HARVESTER.—G. F. KEENE, 35 Quincy Place, Whitman, Mass. This cranberry harvester or berry picking machine is advanced over the ground and is provided with a forked or toothed scoop passing under the berries with the vines passing beneath the teeth of the scoop so as to strip the berries therefrom and permit the same to be deposited in a berry box removably carried upon the machine.

STUMP PULLER.—P. S. LAWTON, 511 Henen Bld'g., New Orleans, La. With the use of this stump puller the stump may be quickly split into two parts and each of these parts may be quickly pulled from the ground, for each part will have no roots extending in one direction, and the roots extending in the other direction may be quickly torn through the soil.

FODDER BUNDLER.—J. L. WOLFE, care of Willshire Lumber Co., Willshire, Ohio. This device is adapted for receiving stalks of corn and for holding them in a compact form in such manner that a tie may be placed on the bundle while so held, and wherein the bundler



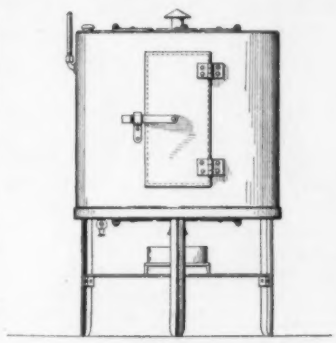
FODDER BUNDLER.

is well supported for easy transportation, and wherein means is provided on the bundler for supporting cord and for permitting the cord to be drawn off to be used as ties for the bundles, and for compressing the bundle prior to the tying.

CUT OFF.—J. L. STEEL, Box 400, Wellston, Ohio. This mechanism is for use in connection with a bin or other holder for seed, grain or the like, so arranged that a portion of the contents of the bin may be withdrawn at any time, by merely pressing down a lever or a handle, and wherein means are provided for retaining the mechanism normally in closed position, to prevent loss of seed or grain.

ATTACHMENT FOR DISK PLOWS.—IRENE DEBY, Lewistown, Mont. Address Rudolph Von Tobel, same place. This is an improvement in attachments for disk plows, and the object is to provide a device designed to steady the plow and hold it in the furrow, especially when plowing in hard ground and when passing over rocks or other obstructions.

INCUBATOR.—C. H. OSBORN, Station D, St. Joseph, Mo. In carrying out this improvement the invention supports a series of trays or pans one over the other around a central vertical metal tube which serves as an elongated chimney for a lamp employed as a heating medium.



INCUBATOR.

The egg trays are supported upon flanges secured to the inner wall of the body or casing of the incubator, and may be rotated thereon to facilitate the introduction of eggs through a door provided for this casing or body.

Of General Interest.

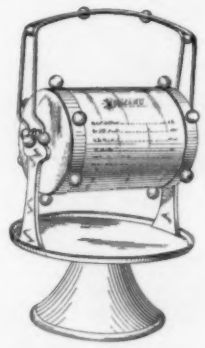
EYEGLASS PROTECTOR.—I. G. BURTON, 1181 Broadway, New York, N. Y. The object of the invention is to provide an improved eyeglass protector arranged for convenient attachment to the rims of the eyeglass lenses with a view to protect the lenses against breaking or cracking in case the user accidentally drops the eyeglass.

IRRIGATING DEVICE.—I. C. BENSON, R. R. No. 4, Caldwell, Idaho. The purpose here is to provide an irrigating device to be used in connection with the laterals of irrigating systems for distributing the irrigating water from the lateral to the soil in a uniform and thorough manner and without waste of the water.

METALLIC SPOOL.—G. A. HERSEY, care of Acme Mfg. Co., Bangor, Maine. The invention relates to spools for containing sewing thread, yarns and the like, and its object is to provide a metallic spool which is simple in construction, cheap to manufacture and exceedingly light, yet strong and durable to allow repeated use of the spool.

UNDERGROUND CONDUIT CONSTRUCTION.—M. H. LOUGHRIDGE, Pleasant Place, Teaneck, Hackensack, N. J. This invention is in relation to a construction of conduit with blocks of molded stone, in which the said blocks form a support for the conduit and a substitute for bends and outlets which can be made at less cost than from the conduit material; also a construction in bends and outlets which may be built up in units to suit requirements and a means of holding these units in alinement and of sealing the joint where they are brought together.

MENU CARD HOLDER.—J. J. CORCORAN, 507 W. 130th St., New York, N. Y. The invention provides a sanitary receptacle to visibly hold a card; provides a device for holding a card within the smallest possible compass; provides a stand for a holder revoluble



MENU CARD HOLDER.

to accommodate a correct viewpoint for the holder; provides supports for the holder, above mentioned, adapted to receive articles used in conjunction with said holder; and provides a holder readily and easily detachable from its permanent or operating position.

NON-REFILLABLE BOTTLE.—J. BELASCO, 870 South Boulevard, Bronx, N. Y., N. Y. This invention provides an apparatus having an outlet valve, the normal or closed position whereof is maintained except when overcome by pressure exerted from within said apparatus; provides a pouring passing and a spring-seated closure valve mounted therein to open outwardly; and provides for said valve protective means for preventing tampering within.

DISPENSING STOPPER FOR INK BOTTLES.—W. I. FERRIS, care of L. E. Waterman Co., 173 Broadway, New York, N. Y. The stopper is so shaped that one side simulates a pouring spout, and at this same side the stopper is provided with a liquid passage so that when the bottle is turned in the act of pouring with the spout-like side lowermost, the liquid will properly flow out, as, of course, the air passage will then be uppermost and admit air freely to the bottle as the liquid flows out.

HAND BAG FASTENER.—H. DIFFANY, 1106 South Broad St., Newark, N. J. This invention provides an auxiliary lock to maintain a hand bag in closed position and to conceal the primary lock thereof; provides means requiring forceful displacement to gain access to the primary lock; and provides a perspective misleading structure to invite attack thereon and thereby to avert attack on the primary lock.

CONCRETE CONSTRUCTION.—W. P. FRANCIS, 39 Luckie St., Atlanta, Ga. The invention provides a construction with panels composed of rows of hollow tile, with concrete joints therebetween, and with the rows of hollow tile disposed at angles to rows of hollow tile in adjacent panels. Each panel is supported on two beams, and the beams distribute the load in four directions on each supporting column for the beams. Reinforcing and tying members are made use of, which are disposed diagonally and over the column, with terminals bent and disposed in substantially parallel planes and embedded in the concrete joints.

Hardware and Tools.

YARDSTICK SUPPORT.—J. A. BERCHTOLD, Sigel, Ill. In this case the aim is to provide an improved structure whereby a yardstick may be connected with a counter or other similar structure in such a manner as to have the yardstick continually in place for use and out of the way when not actually being used.

SCRAPER.—H. A. TUCKETT and V. A. HELLSTROM, 844 E. 1st South St., Salt Lake City, Utah. The invention has for its object to provide a scraper with two pivoted blades, which may be operated back and forth, one of the blades having its cutting edge disposed against the surface being scraped for sharpening purposes, while the other blade engages with the said surface.

LOCK NUT.—W. F. CONROY, Nanuet, N. Y. The object of the invention is to provide a new and improved lock nut arranged to permit of screwing up a nut on a bolt to the desired position, to securely lock the nut against accidental unscrewing, and to allow an operator to unscrew the nut whenever it is desired to do so.

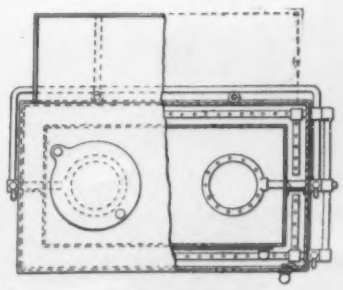
POST HOLE AUGER.—B. G. WATKINS, W. P. WATKINS and T. WATKINS. Address H. L. James, Attorney, Nebawka, Neb. These inventors have obtained Letters Patent for an earth or post hole auger having a single bit or cutter, and for an auger having three bits or cutters. The present patent is an auger having two bits or cutters and a closed bottom intervening the two bits, which construction particularly adapts the auger for rapid and successful work in dry, and light or sandy soils.

Heating and Lighting.

CLOSURE FOR DISTILLATION FURNACES AND PARTICULARLY COKE OVENS.—H. J. LIMBERG, Gelsenkirchen, Germany. This invention relates to closures for distillation furnaces and particularly coke ovens for the dried distillation of coal, lignite, peat, wood or the like. The invention consists in the special formation and packing of the closed door and of the corresponding frame, the improved arrangement having the object of obtaining a perfect joint for the closure.

Household Utilities.

COMBINED HEATING AND COOKING STOVE.—D. CARJULO, 2943 White Plains Road, New York, N. Y. This invention provides a stove which is equipped with an oven and burners for the purpose of cooking on the top of the stove in the usual manner as well as to provide a heat chamber whereby the



COMBINED HEATING AND COOKING STOVE.

stove may be simultaneously used as a cooking and heating stove or independently used for either purpose, with a resultant economy of fuel and the obviating of the necessity of employing a separate heating stove or radiator in a room or rooms equipped with the device. See advertisement on page 86 of this issue.

BATH TUB SEAT.—T. TANAKA, care of Kiso & Co., 59 Beekman St., New York, N. Y. This tub seat may be readily applied and removed, and is simple, strong and effective when in operation. It is flexible when in use and may be readily adjusted for presenting a seat of different heights as occasion may demand.

BUTTER CUTTER.—S. ARAKI, P. O. Box 232, Fromberg, Mont. This machine cuts butter into subdivisions of any desired size, and more particularly it is designed for subdividing the butter into individual portions for serving. The wires are stretched singly, or in any desired number in a suitable frame, according to the capacity of the machine and its adaptation to household use, or to hotel or restaurant purposes.

REFRIGERATOR.—G. E. COXE, Santa Rita, N. M. The invention pertains more particularly to that type of refrigerators generally known as "iceless refrigerators," in which lowering temperature is obtained from the principle of evaporation of liquids, the object being to provide a refrigerator whereby a maximum evaporation may be obtained and a thorough circulation maintained at all times and whereby certain other advantages may be gained.

COOKING CABINET.—J. F. P. MCMULLEN, R. F. D. No. 3, Wakefield, Kan. The aim is to provide a cabinet adapted for simultaneously cooking a number of individual dishes or articles, wherein the heating is brought about by the circulation of hot water, the water being heated by a liquid fuel burner.

OVEN.—J. A. FAIRCHILD, Forest, Miss. The oven has a number of sliding drawers for receiving the baking receptacles, the drawers being so constructed as to allow the circulation of heat throughout the oven, and being adapted to be individually withdrawn without destroying the remainder, whereby to allow access to the contents of any particular drawer with the loss of a minimum amount of heat from the oven.

Machines and Mechanical Devices.

AUTOMATIC INDICATOR FOR PLATE HOLDERS.—C. R. TEIGE and A. L. HART. Address the former, 164 Linden St., Yonkers, N. Y. In this invention the object is the provision of a structure which will indicate the condition of the interior of the holder at all times so that the operator may know whether or not the holder contains one or more plates, and whether or not the plates have been exposed.

Prime Movers and Their Accessories.

ENGINE STARTER.—A. H. KLAHN, 1334 21st Ave., San Francisco, Cal. This invention relates to a starting mechanism of the spring type for internal combustion engines for initially imparting motion to the piston or pistons to bring about the first explosion in the starting of the engine. Means provide for winding the spring by power derived from the engine itself.

STEAM TRAP.—C. A. NUNEZ, American Trading Co., 25 Broad St., New York, N. Y. It is an object of this invention to provide a trap wherein the condensate from the steam is collected until a suitable amount is within the trap, whereupon the trap is automatically opened to discharge this condensate. The discharge opening for condensate is controlled by a sliding valve.

Pertaining to Vehicles.

CRANKING DEVICE.—J. DUNNES, 547 Howard Ave., Brooklyn, New York, N. Y. This invention refers to improvements in cranking explosive engines, and particularly to devices for cranking engines used on automobiles, and has for an object to provide a construction which may be operated in the usual manner without any danger of an appreciable kicking effect against the hand.

TIRE.—R. E. STURMAN, Delano, Minn. In this tire neither punctures nor blow-outs are possible; it has no maintenance cost other than oiling to prevent rust and also to lubricate the sections as they ride upon each other, and when the thread is worn out a new one may be readily substituted therefor, not requiring, as with pneumatic tires, an entire new shoe.

NOTE.—Copies of any of these patents will be furnished by the SCIENTIFIC AMERICAN for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

WE wish to call attention to the fact that we are in a position to render competent services in every branch of patent or trade-mark work. Our staff is composed of mechanical, electrical and chemical experts, thoroughly trained to prepare and prosecute all patent applications, irrespective of the complex nature of the subject matter involved, or of the specialized, technical, or scientific knowledge required therefor.

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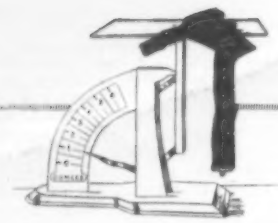

JUST one ounce! That's all that one PARIS GARTER weighs; so you can readily understand why these serviceable garters are so delightfully comfortable for summer wear. They are so soft you'll forget you have them on.

Look for the name stamped on the inside of the shield; when you find it you know you are getting the best.

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No metal can touch you

Who Can Use This New Product With Unusual Physical Properties?

A few years ago a chemist working in the laboratory of the manufacturers of Tanglefoot Fly Paper, developed a product that has a very unusual physical property — and it would seem there must be many places in the arts or manufactures where such a product is needed.

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The Heart of the Locomotive

(Concluded from page 78.)

the valve will be in the exact middle of its stroke. The least motion forward or backward, then, tends to make the valve admit steam to one end or the other of the cylinder. Such a construction would begin to admit steam to the cylinder only *after* the piston had started on its stroke.

But practically this will not work out. It is found that steam should be admitted to the cylinder before the piston finishes one stroke in one direction and begins a stroke in the other. It must do this for several reasons. One is to furnish a *cushion of steam*, a pressure in the cylinder, to help take up the jar and shock of stopping the piston and piston head, before it starts in the reverse direction. Another is to allow the piston to have something to compress, so that when the valve port opens full, the cylinder pressure and the boiler pressure are already about the same, and the tiny interval of time which would otherwise be necessary to bring the cylinder pressure up is saved.

There are other reasons, but these will suffice. The "angular advance," or amount by which the eccentric is in front of its theoretical position, gives the valve what is known as its "lead." The "lead" of a valve makes everything which occurs in the cylinder, that is, admission of steam, cut off of steam, expansion of steam, exhaust of steam, admission of steam to the other end, cut off of *that* steam, etc., occur earlier than would otherwise be the case. But the matter is complicated by the necessity of what is known as "lap" on the valve, that is, the extra length or face of the valve which permits early "cut off" without too early pre-admission of steam to the cylinder.

"Cut off" means what it says, the cutting off of steam. The shorter the travel of the piston during the time steam is coming in, the less steam is used, of course, and the more economy in coal. Early "cut off" allows the steam to expand and use this expansive force which is wasted when the engine is running in full gear without much "cut off."

Here is the real reason for the two eccentrics. If a valve had *no* lap, and the eccentric was at *exactly* 90 degrees with the crank, so that the valve had *no* lead, one eccentric would do for either forward or backward motion, changing from one to the other by a simple link motion. But, in practice, valves do have and must have both "lap" and "lead," and so two eccentrics are necessary (at least in the familiar Stephenson motion), one arranged or set for forward motion and one for reverse.

But the inventors of the Stephenson motion builded better than they knew when they designed the "link" and the two eccentrics. For it was found that the use of the reversing lever, which raises the link through its entire throw, *was not confined to reversing the engine.* When the link is raised exactly half way, each eccentric has an opposite effect upon it, and the valve has but a slight movement. The more the link is raised or lowered beyond this point, the greater becomes the travel of the valve until it is working in full gear.

The engineer thus has at his hand a method of increasing or decreasing the travel of the valve, which, of course, gradually increases or decreases the size of the effective steam opening into the cylinder. Because the economical use of steam demands that its expansive force be utilized, this is of great service to the engineer. The familiar expression, met with even in railroad fiction, of "hooking her up," comes from the use of the reversing lever to shorten the travel of the valve, and this gives the steam a chance to use its expansive power in the cylinder.

But, because of questions of space under a locomotive, eccentric rods cannot be made of infinite length; and with the short eccentric rods, the familiar "hooking up" operation gradually increases the "lead" of the valve, as its travel is shortened. Too much "lead" is as bad as too little—some engineers say worse. And, for this reason, a valve gear which should never change the "lead," no matter how it was "hooked up," has been the aim and end of thousands of inventors.

The peculiarity of the Walschaerts gear is found in the fact that it has only one eccentric, which is in the form of a "return crank" from the main crank on the main driver, and that this one eccentric or return crank does all the work of the valve gear as far as determining the *travel* of the valve is concerned. It operates a rocking link which does not move up or down, and in which the block, connected to the valve, *is* moved up and down by the reversing gear. The "lead" is given to the valve by bringing in a motion obtained from the "cross-head," a "lead" which remains constant, regardless of the position of the block in the link. Hence, the engineer can "hook her up" all he wants, but the "lead" of the valve remains constant.

But the advantages of the Walschaerts valve gear are not confined to a mere matter of constant "lead." Its accessibility commends it highly to engineers who must have the care and oiling and inspection of it. Because it does not take up valuable under-boiler room it commends itself to the designer, who also finds in its much lighter weight a great blessing. The Walschaerts gear transmits its motion from driving wheel and cross-head to valve in almost a straight line, which avoids the errors of distortion found sometimes in the Stephenson gear, which gains its motions from eccentrics between the wheels, and transmits it to a valve considerably to one side. The Stephenson "link," acting under the forces from two eccentrics, moves through a wide angle. A wedging action on the block takes place at high speeds, and this, together with the difficulty of oiling large eccentrics properly and continually, makes the gear sometimes collect "lost motion." Lost motion in a valve gear is about as welcome as a cat at a mouse party, and does about as much damage in the long run. Finally, the Walschaerts gear is said by master mechanics to be more "foolproof" than the ordinary gear. There is less opportunity to "tinker" with it, to experiment in changes in eccentric positions, and its cost of maintenance is less than that of the older, heavier, clumsier mechanism.

It may be of interest to remember that Egide Walschaerts, to whom the railway world owes so much, died near Brussels fourteen years ago, at the ripe age of eighty-one. It is true that he was first a mechanic, lived a mechanic and died a mechanic, that his position in life was always that of a workman, a foreman in the workshops. But Walschaerts was a foreman from choice, not necessity. He hated red tape, thought reports and investigations and office work a bore, and wanted nothing more than a blue print in his hand, a shop to work in, and some engines to work on. As a boy, he had been fascinated by the then brand new idea of railroading. Born at Malines, in Belgium, the connecting of that town by railroad with Brussels in 1835 determined his career. Though he worked on improvements in steam vessels, and stationary as well as marine engines, it was the locomotive which he loved and on which he spent most of his time. He met with great appreciation from the State railways of his country; later all Europe adopted his valve gear, and now the United States is using it as fast as it can be applied.

So it is that a Belgian "grasshopper" is to be found on most modern United States engines, and the traveler who casts a curious glance at the queer rods and joints which give a constant "lead," no matter what the "hook up" or cut off, which make a light mechanism do the work of a heavy, and which tends to strength in the engine by giving space for bracing, should not grudge a moment's thought to the Belgian boy who was content to wear overalls all his life, though he had the capacity to become a wealthy business man, because of his love for the horse of the iron rail, and his never-ending investigations into the mechanism, the mathematics and the physics of that greatest triumph of steel and iron, the locomotive.

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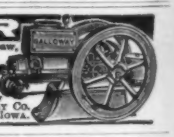

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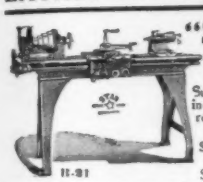

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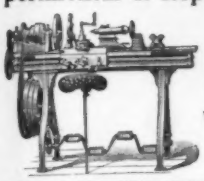

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Modifications of the Walschaerts gear have appeared and are apparently successful, but they all contain the basic principles of the original.

The Thermaphone

A RECENT report from Amsterdam described a Dutch invention which promises to revolutionize the telephone industry. The discovery was made by Mr. P. de Lange, a native of the Netherlands, at the University of Utrecht. The discovery is the more wonderful that it comes announced at the time when Europe is terror-ridden by this disastrous war.

The thermaphone is the name of the new telephone and consists of a telephone receiver and transmitter which is so small that it can be carried in the vest pocket and is no larger than a watch. The magnet and the diaphragm of the ordinary receiver are replaced by a loop of an exceedingly fine platinum wire and a disk of aluminium perforated with fine holes.

The American Consul at Amsterdam, Mr. D. I. Murphy, who writes that he has witnessed a demonstration of the thermaphone at the University of Utrecht, describes it as follows:

"The receiver and transmitter are so small they may easily be carried in the vest pocket, taking up no more space than the ordinary watch. The cost of manufacture is estimated at 30 American cents.

"Notwithstanding its diminutive size, the 'thermaphone'—for so the inventor has named it—appears to have the advantage over the telephone of transmitting messages with perfect clearness and distinctness, vocalization being especially good, and there being no confusion of vowel sounds, letters, or figures. In the thermaphone the magnet and diaphragm of the telephone are eliminated, there being substituted a loop of exceedingly fine platinum wire within a small aluminium cover pierced with minute holes. Currents passing through the wire cause changes in temperature, alternating from heat to cold with great rapidity, the consequent expansions and contractions of the surrounding air becoming evident as sound."

The diminutive size of the receiver being no larger than a lead pencil, makes it possible to place the receiver in the ear and leaves the hands free to take notes during a conversation. Mr. Murphy continues:

"The receiver is so small (being not more than an inch in length and about the thickness of a lead pencil) that it may be placed in the ear, connection being maintained by a thin wire. Either a single or double receiver may be used, and the hands are left free to make notes of any messages transmitted."

The inventor hopes not only to revolutionize the telephone industry, but also has confidence that the instrument may be adapted to the needs of those who are suffering from deafness.

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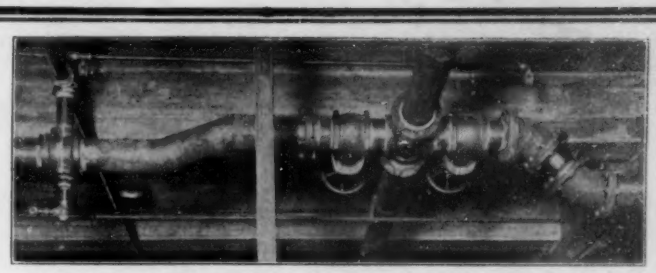

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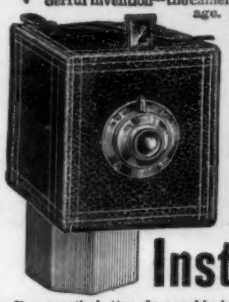

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